THE

ELECTRICAL REVIEW.

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THE

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1900

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"FREE" WIRING.

IN the discussion on Mr. Sellon's Institution paper on the "Standardisation of Plant" (or in some other recent discussion) Mr. Raworth remarked that Mr. Mordey had done more to attain to immortality by misspelling the plural of "dynamo" than by any of his numerous and valuable inventions. The able and brilliant speaker might have added, "It is really most unfortunate that the name of the inventor of that very attractive term 'free' wiring is not known to fame.' It is really so delightfully soothing to the shopkeeper and trader to get something "free," a notion that to him, at least, suggests a present, or an entity of the class—unearned increment. Station engineers are acquainted with the peculiar notions of the individual who is highly satisfied if he can only knock off three or four shillings from a 30 or 40 pound bill by his persuasive eloquence, but who at the same time is firmly convinced that the demand indicator system of supply is but a cumbrous and evil device, devised to hoodwink him and mystify the understanding of his account. He is prone to argue that the price of electricity is the lowest rebated figure, and that the first hour, or initial charge, is an extortionate increase upon this rate. Nothing can induce him to realise that the initial rate is *the* rate, and that the after-charges are reductions upon the normal, or rebates allowed upon the principal rate owing to good custom, and analogous to "discounts on taking a quantity" in every-day commercial life.

Such is the individual to whom the temptation of "free" wiring is offered. He would be delighted with the name, but only those who have had intimate dealings with him, and have had to defend the definition "free" wiring, can fully appreciate the sarcasm of the term. One of those who have had this experience is Mr. E. E. Hoadley, the city electrical engineer of Worcester, and in an interesting article which we print in another column, he gives some authoritative particulars regarding the history of, and results attained by, the National Electric (Free) Wiring Company in Worcester. The company entered that city in 1898, in which year it obtained only 18 consumers. In the next year, 1899, practically the same number were added to the mains, while this year the figure was nine. In all, some 44 consumers dealt with the company in two to three years, a result Mr. Hoadley is quite justified in describing as disappointing. The cause of this want of success appears to have been that the additional penny charged as hire-purchase price on each unit consumed, meant an extra 25 per cent. on the bills for energy—a condition far from making the wiring "free" to the consumer. Because consumers were few, the wiring company desired to be permitted to "free" wire only those lamps burning long hours, and failing to obtain consent to this course, terminated their agreement by

six months' notice. The operations of the company up to the end of 1899 had, we believe, led to the connection of about 1,800 8-C.P. lamps. At other places much better results had been attained: thus at Taunton about 5,000 lamps, at Blackpool 6,500, and at Wallasey the surprising number of about 12,000 8-C.P. lamps had been fitted under the "free" wiring conditions.

Mr. Hoadley met the difficulty at Worcester by advising his Council to go in for assisted wiring on a sort of hire-purchase agreement, quite distinct from the statutory obligation to supply energy. We believe that a somewhat similar plan has been proposed by Mr. Bishop for Wigan, which he calls the instalment system. In his case, the total cost was to be repaid by payments at the rate of 10 per cent. on the completion of the work, and the balance in quarterly payments. At Worcester the work is to be done by local wiring contractors to the designs of the Corporation electric lighting department, while the consumer pays roughly 10s. per £10 for the services rendered by the Corporation officials. The system of deferred payments requires the consumer to pay down on completion of the work one-tenth of the cost of the installation, *i.e.*, the amount certified to be due to the wiring contractor and the Council's fee for the specification, &c., and the balance can, at the option of the consumer, be spread over three, five or seven years, and paid by quarterly instalments, including interest at 4 per cent. on the outstanding balance. On the rental system, a sum of 1s. 3d. is charged annually for every lamp installed on the premises of the consumer. No other charge is made on this system.

There seems to be little doubt that it is bad policy to mix up payments for wiring with electricity bills. The consumer should clearly understand that his account for energy supplied, which is comparable with his gas bill, amounts to so much, and that the other charges are purely of the nature of a hire-purchase payment, whether for electric lighting fittings or for a piano. He is then on a footing with consumers who have bought outright. Further, as Mr. Hoadley points out, the "free" wiring method of charge operates in direct opposition to the principle of the demand indicator, and the knowledge that each unit carries an extra burden of ¾d. or 1d. must tend to deter profitable or long-hour consumers from wiring. The objection to the rental system, that it encourages economy by restriction of lamps, and that it is not likely a man would instal lamps freely in out-of-the-way places equally well lighted with gas, is met by the use of the demand indicator for assessing the energy bill. In any case, the rental system does not seriously deter, even if it does not directly facilitate, the wholesale wiring of houses and small business premises.

The Local Government Board apparently do not intend to block the way by refusing to sanction loans for the purpose of assisting wiring. As the Board is prepared to consider such applications, no objection can be taken to its having fixed the period of repayment at 10 years. We hope that the question of assisted wiring may be fully discussed at the forthcoming Municipal Electrical Convention, and that information in detail respecting its success may be given by the representatives of different localities where it is adopted. Southport, Wigan, Worcester and other places where the instalment and rental systems are being tried are, we consider, going the right way to satisfy the public, and the undertakings, as, in our opinion, nothing is to be gained by the device of calling something "free" that is far from free, or by proceeding on lines that inevitably lead the consumer to believe the price charged for electricity is very high.

Electric Shock Fatality.—On Friday last at Mars Ironworks, Wolverhampton, two men were fatally injured by electric shock. It appears that there is an electric plant at the works used for lighting the premises, and through some misadventure at present unexplained, one of the men unfortunately came in contact with a wire which, it was thought, was not in use at the time, though, as was subsequently discovered, a powerful electric current was passing through it. His companion went to render assistance, and he, too, touched the wire, the result of the shock being that both men received fatal injuries. They were conveyed to the Wolverhampton Hospital, but both died before reaching that institution. Mr. R. A. Wilcock (borough coroner) opened an inquest on the bodies on Saturday, and then adjourned the inquiry for a week. Evidence only of identification was taken. A *post mortem* examination of the bodies has taken place.

Electric Railway Accident in Hungary.—The *Times* Vienna correspondent telegraphing on 5th inst. gives the following account of a fatal electric railway accident which occurred between 8 and 9 o'clock on Monday night in the neighbourhood of Buda-Pesth:—"The line is a suburban one, running between Buda and the picturesque hillside summer resort of Anwinkel. Being a Monday, and the weather being fine, thousands of excursionists had gone out to spend the day there, and were waiting at the station to return. In order to shunt the car on to the down line it is driven up the hill a short distance, and only takes return passengers on coming back to the station. There was, however, a rush for seats before the car could be shunted. The driver had alighted to transfer the regulator handle to the other end of the car, and the guard had, according to his own account, been pushed off in the crush, during which 80 persons had crowded in. It is not known exactly how the brake was let loose, but, before anybody seems to have realised what had happened, the over-crowded vehicle was speeding downhill at the pace of an express train, impelled by its own weight, the electric current having been shut off. After covering about 1½ kilometres, it reached a sharp curve and capsized. The terror of the passengers was increased by the darkness which had already set in. Two men and two women were killed on the spot. There were eight or nine people severely injured, and others sustained bruises and severe shocks."

Obituary.—We learn with deep regret of the death on the 7th ult. of Mr. Frederic Wyles, late assistant electrical engineer at the Waterloo Station since the year 1883, which took place at his residence at Cottenham Park at the early age of 39 years. The late Mr. Wyles was an exceedingly capable officer, and won the esteem and respect of all who knew him, and by his death the L.S.W. Railway Company have lost one who would have undoubtedly forged his way to the front rank of the railway electrical engineering world. The late Mr. Wyles was a member of the Institution of Electrical Engineers, and also of the Society of Arts, and took an active interest in both these societies. The interment took place at Wimbledon New Cemetery on the 12th ult., when there were about 200 railway men present, beside many members of the family, to whom the utmost sympathy is extended in their great bereavement.

Royal Institution.—Owing to indisposition, Sir Henry Roscoe was unable to deliver last week's Friday evening discourse on "Bunsen." The lecture was, therefore, read for him by Sir Wm. Crookes.

BLOWING ENGINE WORKED BY BLAST FURNACE GAS.

An important development in the application of gas engine power has recently been brought to a successful issue at the works of the Société Cockerill, at Seraing. For some years the utilisation of blast furnace gases has occupied the attention of gas engine makers, and in May of 1898 the conditions under which blast furnace gases could be used for motive power were described in a paper read by Mr. Adolphe Greiner before the Iron and Steel Institute.

Since then the solution of the problem has been sought with untiring zeal and energy by the engineers of the Société Cockerill and by M. Delamare Debouteville, and as a result a 600-H.P. gas engine, worked by unpurified gas taken from the Seraing blast furnaces, has been erected, and has been running successfully since November, 1899.

Our illustration, fig. 1, gives a general view of the engine, while fig. 2 shows a 200-H.P. engine worked by a similar gas, and driving a dynamo which has been in use day and night for about two years.

The principal dimensions of the blowing engine are :—

Gas cylinder diameter	...	51 inches
Air cylinder „	...	67 „
Stroke	...	55 „
Revolutions per minute	...	80
Indicated horse-power	...	about 700

From a paper read at the annual meeting of the Iron and Steel Institute by Mr. Adolphe Greiner, we learn that accurate trials of this engine have quite recently been made by Mr. Hubert, professor at the Liège School of Mines, in the presence of Mr. Witz, of Lille, Mr. Bryan Donkin, Prof. Meyer, of Göttingen, and other leading scientific men and iron-masters.

On the first day of the trials (March 20th) the engine was tested simply as a gas motor. The air cylinder was disconnected, and a suitable friction brake fitted. The brake horse-power varied considerably throughout the day from 561 H.P. to 670 H.P., the mean during the trial being 575 H.P.

The mean calorific value of the gas as determined by the calorimetric bomb of Prof. Witz was 984 calories per cubic metre (110 Th.U. per cubic foot). As measured by Junker's calorimeter, it was 860 calories per cubic metre (97 Th.U. per cubic foot). The consumption of gas per brake horse-power-hour was 111·4 cubic feet, and per indicated horse-power 90·86 cubic feet.

On the second day, March 21st, the engine was run as a blowing engine. The quality of the gas appeared to be rather better than on the first day, and the consumption per horse-power-hour correspondingly smaller.

The thermal efficiency is remarkably high. The ratio between the thermal value of the power developed and the heat of combustion of the gas used is 30 per cent. The proportion of work done in compressing air to the mechanical equivalent of gas consumed is 22 per cent., which speaks well for the efficiency of the blower.

This blowing engine can easily furnish blast for a production of 150 to 160 tons of pig per 24 hours at the Seraing blast furnaces.

Owing to the success which has attended the use of the gases from the blast furnaces without any further cleaning than that usually adopted when similar gas is burned in boiler furnaces, orders have been received from a works in Lorraine for three 1,200-H.P. blowing engines for the production of 300 tons of pig iron from oolitic limestone containing 30 per cent. iron. The new engines are expected to blow at 25 to 30 lbs. per square inch when necessary. Our illustration (fig. 3) shows the manner in which the gas is taken from the blast furnaces to the engine.

Fig. 1.—600-H.P. Blowing Engine.

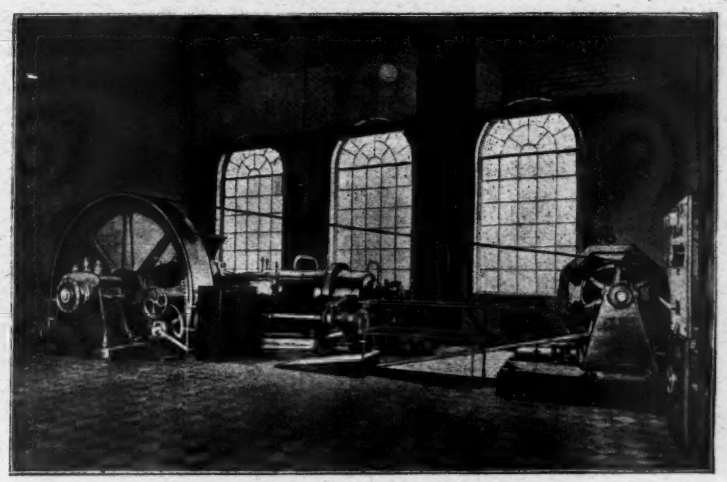


Fig. 2.—200-H.P. Gas Engine.

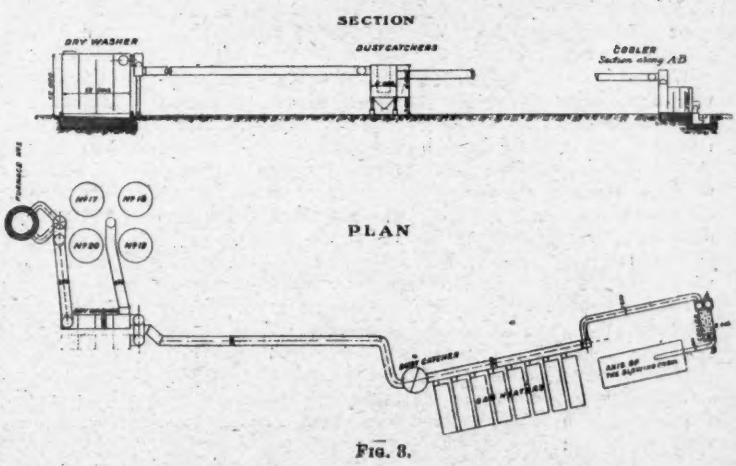


Fig. 3.

E

PATENTS.

[COMMUNICATED]

At the annual dinner of the Association of Chambers of Commerce, Mr. C. T. Ritchie, M.P., President of the Board of Trade, dropped some interesting remarks on the subject of our Patent Laws, referring particularly to the old question of examination into applications for patents.

In Great Britain and Ireland the Patent Office has been supposed to provide abridged copies of specifications of all patents so that an applicant could make a search therein to find out whether his invention was wholly or in part a new invention, and so that he might limit his claims to what was actually new in his own invention. Thus any examination by the Patent Office as to novelty in the invention has been considered superfluous. If the applicant takes out a patent without a search, or knowing after a search that his invention is not new, his patent can be annulled. It is bad and the fault is his own.

Now, this is just the point where some legislation is required. Many bad patents are held and money is raised upon them as good assets for years before they are questioned. Too often are they found without novelty when it is too late.

The abridgments for many years were a long way behind time, and a search only brought up a knowledge of prior patents to within some years, so that even a conscientious applicant might apply for a patent for an invention two or three years old, quite unknowingly. If Mr. Ritchie's committee can bring the abridgments into a shape easily searched and up to date, the difficulties in the way of ascertaining the novelty of an invention will be, to a large extent, removed. But, in spite of every facility for examination by investors and their agents, there is always the possibility of patents being obtained for old inventions and sold as new inventions.

In U.S. America, and in Germany, the applications are subjected to a strict examination by the Patent Office. It is not left to the applicant to make a search to satisfy himself, the search is made to satisfy the Patent Office before a patent is granted; the result is, that no old inventions are repatented.

Of course, we know that Patent Office examinations have their abuses as well as their uses, both in America and Germany; but if the examination were strictly confined to the novelty of the invention, and nothing but published specifications accepted as proof of want of novelty, it would be an improvement on our present system. Examination should not go beyond an inquiry into novelty, for when it extends into the question of patentability, or whether any invention is disclosed in the specification, as is done in Germany, grave mistakes are almost certain to be made and many good inventions refused protection.

What a slight difference there is between an old and inefficient invention, and a new and efficient one, is often a matter of great surprise. The practical man looks at it in amazement, and exclaims, "Why did nobody think of this before?"

We will just take one example in our own line—the three-wire distribution system now universally in use, the patent for which was said to be bad for want of novelty, but was upheld by the High Courts as being good.

The old three-wire system was worked with two outers and a middle wire and with two generators before the date of the disputed patent, but the middle wire was not brought into the generators. This system was called the multiple series system. Dr. Hopkinson and Edison simultaneously conceived the simple idea to connect the middle wire to the junction of the generators. Immediately this was done, an old ineffectual invention became a new and universally successful one. Now one could hardly blame an unpractical Patent Office examiner, comparing the old with the new, for in this case failing to see much evidence of invention, if he drew out a diagram of two generators in series and two series of lamps on three wires; by a stroke of his pen he could join the middle wire to the generators in the diagram. This stroke would be all the difference between the old and the new. It would indicate novelty, and on that ground a patent should be granted; but there would be great danger of an examiner failing to see the invention, and if at liberty to question whether there was invention or not, a good invention might be refused patent protection.

Few errors are made on the question of novelty; the mistakes are made when examiners go into the questions which only highly trained specialists can decide. On the whole, we think examination for novelty would be an advantage in our country.

Another question raised was, that of working an invention in the countries where patents for it are taken out. Many Britons and foreigners take out patents in countries where there is no intention of manufacturing the articles or working the processes patented. The idea is to keep the production at home, and by means of the foreign patents compel the foreigner to import the subject of the patent from the home manufacturer. France has a law which attempts to compel the foreigner to produce in France.

This is a difficult subject to deal with; we have suffered a good deal through this freedom of the foreign patentee. Americans obtain patents here and then claim a monopoly to use and sell apparatus made in America; it is only when the patents are expiring that they commence manufacturing here. This is all, of course, quite legal; Britons do the same thing in foreign countries where it is allowed.

According to the old Patent Law, a patent was granted to protect a "new manufacture," to benefit the inventor for a time of monopoly, and to benefit the community by the "new manufacture." The patent was never designed for the sole benefit of the patentee even at home, much less for the sole benefit of the foreign patentee.

Of course we obtain considerable benefits from all inventions communicated to us, whether production is carried on here or not, but the full benefits to which the community are entitled in return for the grant of a patent cannot be reaped if production is not carried on in the country granting the patent rights; there certainly seems some room for improvement in our patent laws on these points.

Another difficulty which the President did not touch upon, is that which besets the poor inventor who finds his patent infringed by wealthy opponents. The expenses of a patent case are quite prohibitive except to the wealthy, as so many issues can be raised by the alleged infringers. A patents court of justice has been suggested with a specially qualified judge, but whether this would meet the case or not, we must leave our legal friends to decide. It is evident from the President of the Board of Trade's remarks that we are going to have some alteration in our Patents Laws, and as these closely affect our industries, we think the questions touched upon of considerable interest, and worth careful pondering by our manufacturers.

THE SIEMENS DYNAMO AT THE PARIS EXHIBITION.

We illustrate on the next page the Siemens multipolar generator for coupling direct to the Willans vertical triple expansion engine, an illustration of which we gave in our issue of May 4th.

It has a rated output of 2,050 E.H.P., 2,780 amperes at 550 volts, which, however, can be exceeded by 20 per cent. for short periods without risk of injury to engine or dynamo. The normal speed of rotation is 200 revolutions per minute, which is high for such a large output, and as a result the set is of unusually small dimensions and weight in proportion to its horse-power.

The generator is of the type known as Siemens 16 B. 108/21, and the field magnets consist of a circular ring of cast-steel, 14 feet outside diameter, made in two halves. There are 16 inwardly projecting poles, forming part of the ring casting, each of which carries a bobbin wound with high conductivity insulated copper wire.

The armature is of the slotted type, built up of a number of toothed segments of sheet-iron, supported by a cast-steel spider, the built-up core being provided with ventilating ducts. Each slot contains four solid copper bars, insulated with a special material, which retains its mechanical and insulating properties at a higher temperature than the machine can ever attain under working conditions. The bars are

connected so as to form a multiple circuit single-wound drum winding. The end connections are of the barrel type, and they receive thoroughly good mechanical support, so that the risk of breakdown of insulation is reduced to a minimum.

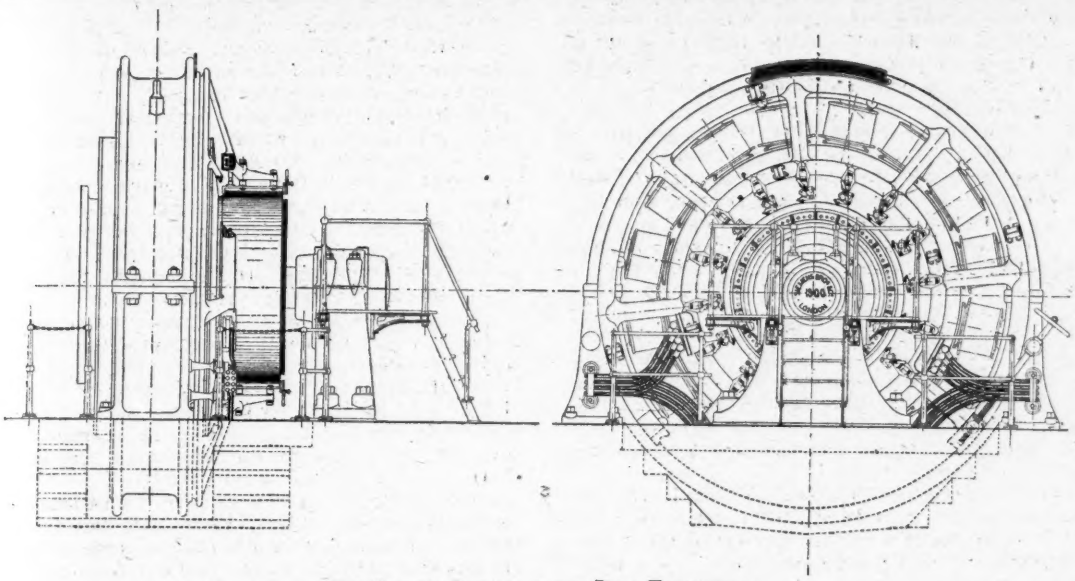
The commutator is 66 inches in diameter, and has 616 segments of hard copper insulated by carefully selected mica of the best quality. It is so arranged as to permit of the removal of sections without pulling the whole commutator apart, and is long enough to allow of axial adjustment of the brushes to prevent ridging.

The brushes are made of specially prepared carbon, 19 to each spindle. They are carried by aluminium holders, and are held with a uniform pressure upon the commutator by means of steel springs. Flexible copper strips are provided which give positive contact between the brush holders and the gun-metal bar to which the cable connections are made.

The brush arms are fixed by insulated bolts to horizontal projections from the cast-iron ring which can be rotated for adjustment of the brushes in the usual manner.

The sole plate of the dynamo carries an outer bearing provided with a stair and rails for inspection and for attending to the lubrication.

The weight of the dynamo, complete with sole plate and bearing, is 60 tons, the armature, including commutator and spindle, weighing 29 tons.



The Siemens Dynamo at the Paris Exhibition.

THE TOWNS' REFUSE PROBLEM.

(*Concluded from page* 946.)

Unless the term refuse destructor is a misnomer, the apparatus must be capable of dealing also with street sweepings, which are not valuable as fertilisers to any degree, and thus are not of value to land, and will not burn in an incinerator unless mixed with house refuse in a considerable proportion. Road sweepings form no inconsiderable proportion of the house refuse. The quantity of town refuse collected ranges from 300 to 400 tons per 1,000 of population per annum, while the road sweepings have been estimated by one authority at about 150 tons per 1,000 of population per annum.

It is clear that the heat value of such material must fluctuate between very wide limits, and that any such result as even 1 lb. of water evaporated from and at 212° F. per pound of refuse must have been achieved under more or less exceptionally favourable conditions, and cannot be taken as the figures that would be arrived at on dividing the number of pounds of water evaporated from and at 212° F. during any one year by the number of pounds of *completely consumed* refuse passed through the furnace.

The essential feature in an incinerator should be the complete combustion of the refuse consigned to it, thus rendering the products of combustion absolutely innocuous and in no sense a source of annoyance to those living in the neighbourhood. A very frequent complaint is that the escaping gases carry with them fine particles of dust in suspension, which are carried to considerable distances when there is any wind, and become a source of great annoyance. This can be overcome by care in the design of the flue leading from the furnace to the chimney and by attention in the charging and working of the incinerator. In the discussion on Mr. Newton Russell's paper, which was read at the Institution of Civil Engineers last session, Mr. Stephen Terry drew attention to two ingenious devices which he had patented for ridding the flue gases of all dust. The principles upon which these apparatus were based were similar in each case, the area of the flue being increased, thus reducing the velocity of the gases, and deflecting planes, against which the gases impinge, being placed in the flue in such a position that the dust collected fell into suitable bins.

In earlier types of incinerators the odour given off from the chimney was more often than not of an extremely offensive character; so much so that Mr. Jones, of Ealing, introduced what he called a fume cremator, by means of which the gases were rendered odourless and innocuous. The cost of working the fume crémator was a considerable item in the total cost of destruction, and with modern high temperature furnaces the need for a separate fume cremator is minimised. Even with the best constructed furnaces it is quite conceivable that with certain kinds of refuse the products of combustion may carry with them an objectionable odour unless the working of the furnace is regulated according to the character of the refuse charged, and the experience of those living in the neighbourhood of incinerators bear out this contention. Every effort in the management of an incinerator plant should be directed first and foremost towards the fulfilment of this one absolutely essential condition—the complete combustion of the refuse and the deodorisation of the escaping gases.

From the very nature of refuse, combined with the variability of our climate, it is quite clear that the "average" value of refuse is little more than a mere figure of speech, the heat value of the refuse received at an incinerator must vary within very wide limits with every load that is brought in, and thus is entirely unsuitable for the production of steam to anything approaching the extent corresponding to the "average" heat value, if an approximately constant load proportional to this average value is to be provided for.

Undoubtedly the heat produced by the burning of the refuse can be put to some use, but it must be for some purpose which does not depend for its efficiency or economy upon a more or less constant heat supply. Up to the pre-

sent, it may be said that the only really satisfactory use to which the heat of combustion of refuse has been put is in grinding up the clinker from the furnace for manufacture into concrete paving blocks or mortar. Where there is a demand for this, the cost of working the incinerator can be very greatly reduced by the profit on the sale of this product.

We are not aware of a single instance of electric light being economically and satisfactorily produced by steam generated in boilers combined with incinerators where refuse, and refuse only, is burnt. In the case of the incinerator at Shoreditch, which is freely quoted by advocates of the principle of obtaining electric light from refuse, it will be found that, according to the figures given in Mr. Newton Russell's paper, 3 lbs. of coal were burnt per unit of electrical energy generated, in addition to all the refuse. Now, the Pall Mall and St. James's and the Westminster Electric Supply Companies, both of whose load factors do not appear to be so good as that obtained at Shoreditch, manage to generate a unit with about $5\frac{3}{4}$ lbs. of coal; therefore, the value of the refuse at Shoreditch would appear to be equivalent to that of $2\frac{3}{4}$ lbs. of coal per unit generated.

Now, during the year ending March 25th, 1899, the total energy metered to consumers from the Shoreditch plant, including 131,140 units supplied to the refuse destructor for various mechanical purposes, was 1,031,348, corresponding to, say, 1,150,000 units generated. The refuse burnt was 26,201 tons, which, according to our argument above, must be equivalent in calorific power to

$$\frac{1{,}150{,}000 \times 2{\cdot}75}{2{,}240} = 1{,}410 \text{ tons of coal.}$$

Hence 1 lb. of refuse should be equivalent to $\frac{1{,}410}{26{,}201}$ lbs. = 0·054 lb. of coal, and as such coal may be taken to be capable of evaporating 10 lbs. of water from and at 212° F., the combustion of 1 lb. of this refuse should be equivalent to an evaporation of 0·54 lb. of water from and at 212° F. This, in our opinion, is much nearer the result that may fairly be expected from the combustion of refuse in practice year in year out.

It is not possible to arrive more accurately at the water evaporated per pound of refuse over the whole year, since Mr. Newton Russell points out that the coal burnt was mixed with the refuse in generating the above number of units, and the only test mentioned in the paper in which ordinary domestic refuse alone was used is one of five hours' duration, when a little under 1 lb. of water is stated to have been evaporated from and at 212° F., by 1 lb. of refuse. It is hardly necessary to point out how entirely unreliable such a result must be, as during so short a test, even with coal in an ordinary boiler, it would not be easy to minimise the effect of unavoidable inaccuracies of measurement, but when dealing with refuse as a fuel, the possible difference between the state of the fire at the commencement and at the end of the test would have a considerable influence upon the evaporative result obtained.

Further, it is not likely that such a test would be carried out at an obviously unfavourable time, hence it must be taken as being—if anything—above the average of the result usually obtained. Even 24-hour tests of an incinerator do not yield any reliable results upon which to base the performance of incinerators generally—unless, of course, the 24-hour tests are repeated at sufficiently frequent intervals over a complete year. The variation in the character of refuse during the winter months and during the summer is most marked; in fact, it is doubtful whether house refuse in summer can have any appreciable calorific value, as cinders, except from kitchen fires, are of course absent. The five-hour test above alluded to took place on January 10th, 1899, from 8 a.m. to 1 p.m. What result might reasonably have been expected had the test been carried out in July or August, witness deponeth not; nor would it, we think, be in the interests of "gold from the dustbin" theorists that a trial of house refuse as a fuel should be made at such an exceedingly unfavourable and doubtless equally inconvenient time, even though it is merely intended to compare with results obtained during a convenient and favourable period.

It must be remembered that our remarks are directed chiefly towards the value or otherwise of an incinerator for steam raising. We do not suggest that the heat of combustion cannot be utilised, nor that it should not be utilised, but having regard to the variable character of refuse from load to load, during winter and summer, and in various towns, we assert that it is in the highest degree misleading to attach any value whatever to the calorific value of "average" refuse. There is no such thing as average refuse. Mathematicians may join issue with us on this point, but we mean that beyond a mere numeric the figure arrived at as the calorific value of average refuse has no significance to practical men. What would be thought of the engineer who burnt megass, and peat, and lignite, and brown coal, and Welsh coal, and anthracite in his boiler furnace, and then attempted to give a definite value to the average calorific value of his fuel, especially when he did not know whether Welsh coal or peat would be the next load thrown into his store?

Mr. Healey, in his recent paper on the economic disposal of town refuse, draws attention to several important points which should be observed in order to ensure the apparatus working at its greatest efficiency as an incinerator. He points out that regularity should be in all operations so as to maintain, as far as it is possible with such fuel as refuse, a minimum amount of fluctuation of temperature in the furnace. The tendency of workmen is to clinker and level up all the furnaces as rapidly as possible, which would be followed by a considerable interval during which no work would have to be done. During the earlier part of this interval, however, the temperature of the furnaces will fall very considerably, and as a result the gases will escape after being only partially consumed, thus defeating the primary object of the incinerator.

Mr. Healey also refers to forced draught for incinerators, but does not, we think, lay sufficient stress upon the great importance of mechanical draught (whether forced or induced) as an element in the successful destruction of refuse.

Owing to the very variable nature of refuse, it is essential to employ some means of furnishing the necessary air for combustion, which admits of variation to suit the type of fuel to be burnt. Natural draught is a function of the difference of temperature at the base of the chimney, and of the surrounding atmosphere. At a time when the temperature of the destructor furnace has sunk, owing to some particularly wet loads of refuse which may have been tipped into the furnace, the temperature of the gases at the base of the chimney will have sunk to a proportionate extent, thereby weakening the draught just at the time when it ought to be stimulated. The condition of the atmosphere also has a considerable influence upon the extent of natural draught, which therefore varies according to circumstances quite outside the control of the stoker.

With mechanically stimulated draught, the air spaces between the fire bars need not be more than $\frac{1}{4}$ to $\frac{3}{8}$ths of an inch wide, which is of very great importance in a furnace which has to consume a large proportion of dust and sundry small particles of matter.

Mr. Healey devotes a considerable portion of his paper to the subject of boiler setting and the arrangement of flues. The latter has an important bearing upon the degree of completeness with which the deleterious constituents of the products of combustions are got rid of. Mr. Healey also seems to take for granted that high temperature furnaces are essential for complete incineration. While our sympathies are entirely with Mr. Healey in this direction, there are, we believe, some authorities who still advocate low temperature furnaces.

Mr. Healey also mentions the subject of moving firebars, but does not enter into a discussion of the relative merits of the various systems in use. It may be assumed that moving bars are essential to even moderately successful burning of refuse, but there are many types of moving bars, as well as methods of moving them, which have an important bearing upon the efficiency of refuse destruction. No doubt the best results are attained when the motion of the fire bars is designed not only to break up the clinker and keep the air spaces free, but which also feed in the refuse.

In concluding his paper, Mr. Healey suggests a method of standardising the results of official and other trials. We cordially endorse Mr. Healey's views in principle, but regret to find that not sufficient stress is laid upon the time element in such tests. When dealing with refuse destructors from the point of view of general usefulness, one is not concerned so much with finding out what is the best

possible performance of which the incinerator is capable, as with the determination of its average performance throughout what might be termed one complete cycle of its fuel supply. The results obtained during 24 hours are no criterion as to what the performance would be during any other period of 24 hours, and as the character of the refuse varies with each season of the year, it becomes clear that a record of results, extending over a period of one year, would yield the only reliable data upon which to base an estimate of the value of the incinerator as a means of destroying refuse or of raising steam.

CURRENT SPECIFICATIONS.

XV.—MANCHESTER TRAMWAY EQUIPMENT.

Summary.

Scope of Tender.—Overhead equipment of three routes of electric tramways.
Total Length of Line.—About 9½ miles.
System.—Overhead double trolley system, part to be span wire and part centre pole construction.
Specified Date of Completion.—October 31st, 1900.
Penalty for Late Completion.—£50 per week.
Stipulations as to Payment to Workmen.—Unsatisfactory. See below.
Stipulations as to Removal of Foreman.—Satisfactory.
Stipulations as to Arbitration.—Satisfactory.
Specified Terms of Payment.—80 per cent. on material delivered and work done as work proceeds; 10 per cent. six months after completion; 10 per cent. 12 months after completion.
Date for Receipt of Tenders.—June 30th, 1900.

Mr. C. H. Wordingham, M.I.C.E., the well-known city electrical engineer of Manchester, is responsible for this specification. It is interesting from the fact that though only 9½ miles of track are at present to be converted to electric traction, this will be rapidly followed by other routes until the whole of the extensive network of tramway lines for which the city has long been noted are electrically equipped. It is a striking evidence in favour of electric traction that as soon as the lines have come into the possession of the Corporation a change from horse to electric traction has been decided upon.

Centre pole construction is demanded for about a quarter of the route now scheduled for conversion, the greater part of the remainder being equipped on the span wire system.

Feeder cables will be laid under another contract, and although provision is to be made in the tender for fitting the pole bases in position, these will be supplied to the contractor by the Corporation.

As there are difficulties in the way of definitely determining at the present time the exact system to be adopted at all points along the route, a bill of quantities has been prepared and sent to tenderers, so that it will not only be possible to directly compare the different offers received, but also to adjust the contract sum to suit the actual work done.

Extra prices are asked for at which the contractor will provide and fix arc lamp brackets for either centre or side poles.

A number of designs as well as samples of fittings are to be sent in with tender, to enable the Corporation to rightly appraise the different offers they receive, and a number of stringent tests will be made with the insulating material proposed to be employed. The insulation resistance of the line, when completed, must be such that it passes the following test:—

The insulation resistance of the up and down trolley lines respectively shall be tested (*a*) when the line not under test is insulated; (*b*) when the line not under test is connected to the earth. The insulation resistance shall, in case (*a*), be not less than 20,000 ohms, divided by the number of miles of trolley line included in the test, and in case, (*b*), not less than 10,000 ohms, divided by the number of miles of trolley line included in the test. In both cases the measurements being made in damp weather, and the resistance determined after electrification for one minute with the negative pole of a battery giving not less than 500 volts.

The trolley wire is to be double throughout, and of 0·4 inch diameter, the line being suitable for use in conjunction with a straight under-running trolley.

The date of completion is comparatively short, and in view of the heavy penalty, the following clause seems to be unnecessarily severe:—

The Corporation will afford to the contractor all reasonable facilities for the convenient execution of the works, so far as shall in the opinion of the engineer be consistent with the due progress and management of the tramways on or in connection with which the works are being carried out, and with the terms of the contract, but *the execution of the works must at all times be held to be subservient to the necessities of the generation of electrical energy at the electric works*, and *the Corporation shall not be held responsible for any delay, inconvenience, or extra expense that the contractor may incur because or on account of the necessities of the process of generation of electrical energy.*

It is quite right that due regard should be paid to the importance of non-interference with the continuity of electric supply to the city, but discretion should be allowed the engineer to grant some compensating extension of time for any undue delay thus caused.

Sunday work is strictly prohibited, except with the express sanction of the Corporation.

In dealing with the Leeds contract a few weeks ago, we found it necessary to call attention to the unsatisfactory labour conditions included in the general conditions, and we must again adopt the same line of action. In all probability the attempts made by so many of the municipal authorities of our larger towns and cities to impose in their contracts conditions which interfere with the relationship of employer and employé, is due to the presence upon these bodies of representatives of the so-called labour parties, who think that in this way they help forward the socialistic millenium which they profess will cure all the social ills of the present body politic.

The objectionable clauses in this contract relate to subletting and the payment of standard rates of wages. We reprint them in order that our readers may judge for themselves. Although a contractor may himself be willing to pay fair wages to all his employés, and not only those employed on one particular contract, it is not *a commercial risk* for him to render himself liable to the unconditional determination of his entire contract with all its attendant penalties, because one of the firms from whom he purchases material infringes one of the following regulations either as regards piecework or rates of wages:—

The contractor shall execute the works *by his own workmen*, working directly under the contractor *at a daily or hourly rate of wages*, and (except with the consent of the Corporation) *not by the piece or according to results. The contractor shall not* assign or sublet the contract, or any part thereof, or *enter into any sub-contract or arrangement (written or oral) with any person or persons for the execution of the whole or any portion of the works*, except with the consent, in writing, of the Corporation under their common seal; and in the event of such consent being ever accorded, then except under and subject to its terms and conditions in every respect. *If the contractor shall assign or sublet any portion of the contract* contrary to this provision, or by himself or his agent shall give or offer any gratuity to any servant or agent of the corporation, he shall (without prejudice to the other remedies of the corporation) forfeit to the corporation a sum of £100 for each such assignment, sub-letting, gratuity, or offer, and such sum or sums may be deducted by the corporation from any moneys payable to the contractor under the contract, or may be recovered from him as liquidated and ascertained damages, and not by way of penalty. *For the purposes of these conditions* the *employment of a foreman or workmen to execute the works, or any part of the works, in consideration of the payment of a sum or sums by the piece, or according to results (except where the written consent of the corporation shall have been obtained to that mode of payment), shall be deemed a sub-letting of portion of the contract.*

Clause 30 referring to rates of wages, reads:—

The contractor declares that the contractor now pays, and the contractor hereby undertakes that the contractor and the executors, administrators, assigns, *or sub-contractors of the contractor*, or any other person who may for the time being be bound or authorised to execute and perform the obligations of the contractor under the contract, or any part of it, *shall and will continue to pay during the subsistence of the contract to his, her, or their workpeople the regular standard of wages obtaining in the City of Manchester, if and so far as the work is executed there, or otherwise in the district in which the work is executed*, as the case may be. *Compliance with this condition is of the essence of the contract*, and in the event of any person or persons being employed at any time, or from time to time, in or about the work at a rate of pay or wages less than such regular standard of wages it shall be lawful for the Corporation, by notice under the hand of the town clerk, to require the contractor, or the executors, administrators, assigns, or sub-contractors of the contractor, or any such other person as aforesaid, to forthwith pay to such person or persons so employed the regular standard of wages as aforesaid; and *if any payment is thereafter made to such person or persons so employed at less than the regular standard of wages as aforesaid*, it shall be lawful for the Corporation, and they are hereby expressly authorised, either by resolution of their tramways committee, to be confirmed by the Council of the said city, or by substantive resolu-

tion of such Council, *absolutely to determine the contract*, which determination shall take effect from and after the date of such confirmation or such resoluti n of the said Council; provided always that *such determination shall be without prejudice to all claims either of the contractor or the Corporation for*, or in respect of, work executed, or materials supplied and accepted, or matters arising prior to such determination, but *such determination shall not entitle the contractor to make any claim against the Corporation for damages or otherwise in respect thereof, or of any loss or expense which may accrue to the contractor in consequence thereof*; provided also that nothing in this clause contained shall be deemed to authorise or entitle the contractor to assign or sublet the contract, or any part of it.

THE 3,000-VOLT THREE-PHASE RAILWAY AT COLICO, ITALY.

By E. K. SCOTT.

FROM an electrical novelty point of view, probably the most interesting exhibit at the Paris Exhibition will be the plans, details of the electric cars, &c., for the 65 miles of electric railway which the Adriatic Railway Company are laying down at Colico, Italy; the bare conductors from which the trains draw their energy being worked at a pressure of 3,000 volts.

The objects to be exhibited include details of the line equipment, models of a transformer sub-station and a parlour motor carriage of 300 H.P. besides switches and other details. These will be exhibited in a pavilion which is being specially built by the Adriatic Railway Company, and which will be ready by the end of July. The line itself will not be ready for use before the end of 1901, but Messrs. Ganz and Co. erected some six months ago, an experimental line of 1·6 kilometre at Buda-Pesth on which all the details are being carefully worked out.

The lines being converted are those of Lecco-Colico, Colico-Sondrio, and Colico-Chiavenna, which are at present worked by steam.

The necessary power will be derived from a 98-foot fall on the River Adda; the head race is three miles long, and at the power station at Morbegno (10 miles from Colico) 10,000 H.P. will be available. It is proposed to erect three units of 2,000 H.P. each, consisting of turbines and Ganz three-phase alternators, generating current at a pressure of 20,000 volts and 15 periods per second.

At intervals of about 6½ miles there will be 10 transforming stations, reducing the pressure to 3,000 volts on the trolley wires, which are 8 mm. in diameter. Both the primary and secondary lines are on the same poles, except in the tunnels where the lines are fixed to the roof. The two overhead wires are 3 feet apart and the rails form the third conductor. The passenger motor cars are to have four motors, each 150 H.P. Two motors only will be in circuit at the maximum speed of 38 miles an hour, the other two being thrown into circuit, when the train of 65 tons weight ascends gradients of above 1 in 100 at 19 miles per hour. When the four motors are in use two of them take current not from the trolleys but from the other two motors; in this way it is said that the speed is reduced to one half without loss of energy. There are to be five passenger trains and two freight trains, the freight trains being run at about half the above speeds and having a maximum capacity of 200 tons, they are hauled by a 600 H.P. locomotive.

The whole of the line is divided into single parts, each of which is supplied with current from the sub-station next beyond it, this being done to ensure greater safety in working. When one block signal indicates "stop," the next part of the line is not supplied with current, and in case of interruption of current the Westinghouse brake comes on automatically, an important feature, on a line with steep grades.

This line is of international importance, because the Adriatic Railway Company is one of the two largest railway concerns in Italy, controlling as it does the whole of the railway network down the eastern portion of the kingdom.

The decision to undertake the work is the direct result of the successful operation of a short length of electric railway from Milan to Monza, and it is further interesting to note that the company are so pleased with the way things are shaping, that they already contemplate equipping electrically the Bologna Firenze line, which is several hundred miles long, and crosses the highest points of the Appenine range of mountains.

The Mediterranean Company, who control the railway system on the west of Italy, are following suit, and have already obtained the royal decree to a project, which will require 10,500 H.P. Electrical engineers, and also railway engineers, will therefore need to watch these Italian developments closely, for as was the case with the Tivoli Rome transmission, it is again falling to Italy to give the engineering world a lead.

CYLINDER CONDENSATION.

IT is a strange thing that the interaction of the metal of a steam engine cylinder, and of the working steam, has received so little attention from engineers, though it must have been recognised by Watt when he wrote the words "keep the cylinder as hot as the steam that enters it," this being the object he sought by the steam jacket. Watt must have had very clear ideas on steam engine economy, for he made of his jacket simply an enlarged passage way for the steam on its way from the boiler to the engine. These jackets are simply thoroughfare jackets, and their action has been described as resembling the robbing of Peter to pay Paul. But this is hardly a correct view to take of the action that occurs.

If steam were a non-condensable gas the above view would be correct. In such a case, however, the jacket would not be needed. Steam is a readily condensable gas, and for practical purposes may be considered as containing two separate quantities of heat: (*a*) that necessary to raise the temperature of the water to the point of ebullition; (*b*) that necessary to convert this heated water into steam without change of temperature. This second quantity of heat is usually termed the latent heat. Its disappearance from steam reduces the steam to water without reduction of temperature. Its addition to water simply increases the kinetic energy of the molecules, enlarging their path and velocity, and steam results. When the steam to an engine is first passed round the jacket, it keeps this as hot outside as though it were immersed in the boiler, and this added temperature causes a flow of heat through the cylinder wall towards the cooler inside surface.

The inside surface is cooler, because it is not always exposed to steam of full pressure. For half the time it is exposed to the exhaust temperature, and rarely is it exposed for more than a quarter of the time to full boiler temperature. If heat thus travels from the jacket to the inside of the cylinder, this heat must come from somewhere. It comes from the latent heat of the steam in the jacket, and by this abstraction the steam is reduced to water. Here comes in the important point to be observed, neglect of which has led to such erroneous conceptions of jacket action. The jacket is maintained at boiler pressure and temperature because it is at the boiler side of the engine valve, and with sufficiently large steam pipes is kept fully supplied. We have thus arrived at the fact that in preventing some of the condensation in the cylinder, other condensation has been made to take place in the jacket, where, then, does the economy come in? It comes in at the fact that the water formed in the jacket may to a large extent be drained out of that jacket as water. If the cylinder is above the boiler, the water will flow back to the boiler by gravity, returning to the boiler all but the latent heat that has gone in keeping the cylinder warm, or, rather, in warming it ready to receive its next charge of steam. Condensation has been transferred from a vessel in which the pressure varies through wide limits every stroke to one in which pressure is constant. It is in the oscillation of pressure, and, therefore, of temperature that water is enabled to play its part as a wasteful agent in the cylinder.

During the exhaust stroke the contents of a cylinder fall to exhaust pressure. Any water present in the cylinder begins to evaporate as soon as the cut-off valve closes, and the pressure falls lower and lower. Steam is given off in such volume that the terminal pressure in the cylinder is always higher than the hyperbolic curve. It ought to be

lower, and it would be lower in a cylinder that neither absorbed heat from nor gave out heat to the working fluid.

The steam thus given off absorbs its latent heat from the cylinder walls, and so long as any water is still unevaporated, it will continue to evaporate until the metal of the cylinder is reduced to the temperature corresponding to the exhaust pressure. The more slow the rotative speed of the engine the greater will be the perfection of this re-evaporation, and the deeper into the cylinder wall will extend the cooling effect. Similarly will the time of action of the jacket be increased. Whence follows the general experience that jackets are more efficient on slow speed engines than on those of rapid rotation.

It equally follows that if by any means the cylinder could be maintained throughout as hot as the boiler, there would never be any water condensed on its interior surfaces, and there could be no re-evaporation, for there would be nothing to re-evaporate, and there would be very little cooling of the cylinder during exhaust. In the thoroughfare jacket, water has been kept out of the cylinder, and by so much is there less re-evaporation to perform, and economy results. It is possible to imagine instances where even well-designed jackets are wasteful. This might be the case where the steam entered the cylinder very wet, and there was a large mass of water re-evaporated during exhaust, but with fairly dry steam a jacket cannot be conceived to be capable of causing loss if well designed and drained. The Corliss valve obtained a high reputation as an economical valve, and gave a huge fillip to sharply acting cut-off motions, because its real action was not at all realised. Placed opposite the exhaust port in horizontal engines all water entering the cylinder with the steam was shot directly across the cylinder into the exhaust port. No doubt some of it was evaporated during expansion, but it absorbed no heat from the cylinder walls, and when the exhaust valve was opened, the water it supported was hurried away at once. The Corliss valve was successful as a cylinder drier, not as a cut-off valve.

It is perfectly obvious that, except for such differences as may be introduced by the clearance volumes, all steam engines working at equal pressures and expansion would be equally efficient if they had cylinders possessed of that impossible quality denoted by the term adiabatic. This being so, it is equally obvious that the relative efficiency or economy of steam engines working at the same pressure and expansion ratios must be entirely governed by the factors that control the interaction of the steam and the cylinder walls. Given dry steam throughout the stroke, there could not possibly be any re-evaporation, and the calculation of efficiency would follow on the lines set down by Rankine. In practice, the efficiency obtained depends upon those factors that determine how much water there shall be in the cylinder. These factors are, in the main, four in number. They are the ratio of expansion; the ratio of the internal surfaces to the weight of steam contained by them; the quality of such surfaces; the rapidity of movement or reciprocation. The ratio of expansion is, of course, closely connected with the ratio of the internal surfaces.

The immediate effect of preventing cylinder condensation, and at the same time not varying the cut-off, is to reduce the power of the engine. This has probably led some observers to doubt the value of devices for preventing condensation. But the reason is not far to seek. By preventing the condensation a much less weight of steam is admitted to the cylinder up to cut-off point. In each case the cylinder is full of steam to the same point, but in one case there is a large quantity of hot water, and in the other little or none. The water evaporates as expansion progresses, and fattens up the diagram, but it is a wasteful means of producing steam. With dry steam in order to get equal power the cut-off must be a trifle extended, so as to admit the necessary amount of steam to give the requisite diagram area. But even then the steam really admitted is less in weight than when the steam was wet. In this latter case, probably one-third of it condensed during admission. More steam really entered but did not make itself felt; it did not appear on the indicator diagram at cut-off. More was thus visible just before the exhaust opened, and a measurement of the discharge from the surface condenser would show even a greater increase.

The apparent anomalies in steam engine practice all arise from the causes which lead to the phenomenon of condensation, and would all be explicable did we know the true facts as to these causes.

FREE WIRING.

By E. E. HOADLEY, A.M.I.E.E., City Electrical Engineer, Worcester.

In a great many places in England there are stations that have been in operation for five or six years, and are now getting into that condition in which their maximum load or their lamp connection does not increase so quickly as it did in the first two or three years of their existence; in other words, the chief public buildings, business premises, hotels, and those private houses whose occupiers can well afford to pay for their installations are already taking a supply, and some inducement is necessary in order to get the smaller shopkeepers and the occupiers of the smaller houses to use electricity.

The chief obstacle to its use by this class of people is undoubtedly the large amount of money which must be spent to cover the first cost of wiring and fitting up their premises, premises of which in many cases they are only quarterly tenants.

That it was desirable to assist this class of consumer was recognised some few years ago, and for this purpose (among others) the National Free Wiring Company was formed. This company has started operations in a great many towns in this country, and by its efforts a very large number of consumers have been connected to the mains by the various companies and municipalities; consumers who in all probability would not otherwise have become users of electricity.

Here, in Worcester, the Free Wiring Company started in 1898, but owing to various causes has not met with as much success as elsewhere. In 1898 only 18 consumers were obtained by the company, in 1899, 17, and this year, down to the present date, when the company's connection with Worcester ceased, nine.

These results can only be looked upon as disappointing; investigation and inquiry from consumers have elicited the following as the probable causes:—The business was worked in conjunction with another town, in which the supply was just being started, and where customers were plentiful; for this reason business in Worcester did not receive that amount of push which was necessary if many consumers were to be obtained.

Consumers complain that the clauses in the agreement relating to purchase of the installation are unnecessarily harsh, and that the extra charge of 1d. per unit on all electricity consumed is practically an addition of 25 per cent. to their electricity bills, and in the case of publicans is even more, being very nearly 30 per cent.

Last autumn the Free Wiring Company gave the Corporation notice that, in order to make things pay in Worcester, they would be unable to wire bedrooms, &c., on the free wiring system, and could only wire them if they were paid cash for such lights, and asked to be allowed to amend their agreement to that effect. To this the Corporation would not agree, as the larger proportion of the free-wired consumers were drawn from the occupiers of private houses, and the system would not be of much benefit to these unless a man could have his bedrooms wired. To this action of the Corporation the Free Wiring Company replied by giving the necessary six months' notice to terminate their agreement.

At this stage, as I was convinced of the benefit of helping a consumer to wire his premises, I induced my Committee to go in for a scheme of free wiring for themselves. A scheme was prepared by the town clerk and myself, approved by the Council, and as great doubt was expressed as to whether the Local Government Board would grant a loan for such a purpose, a letter was written to the Local Government Board asking if they would entertain an application for a loan for free wiring. The Board replied that they were prepared to consider such an application, but if they did grant a loan it would have to be repaid in 10 years.

shaping, that they already contemplate equipping electrically

always higher than the hyperbolic curve. It ought to be

After this reply, application is now being made for a loan of £1,000 for free wiring purposes in the city of Worcester.

In our scheme the chief points that were kept in view were:—(1) To make it as cheap and attractive as possible to the consumer; (2) to allow the consumer to pay for the installation in almost any way that suited him best; (3) not to interfere in any way with the trade of the local contractors, but to further the putting in of good work and well designed accessories; (4) in cases where the consumer only hires the installation, to charge him a rent calculated at a certain sum per lamp installed, and not to add a certain sum to his electricity bill for every unit of electricity consumed. That there is a good deal to be said for and against each method I am well aware, but an experience of both methods has led me to believe that the charge per lamp installed is the better way.

The chief objection to this is that it is possible that a tradesman may only instal lamps in his window or shop, where he uses them but a very little time per day, and may not instal them in dark passages, &c., where he will use them many hours per day. This objection, however, will, in some measure, be overcome, as each installation will be planned, &c., by an official of the Corporation Electricity Department, who will advise the consumer how to use his lamps to the best advantage.

By the other method the best customers of the electricity works are penalised most, and many people who would be profitable consumers from the works point of view, *i.e.*, would use a large number of units per lamp installed, are deterred from having their premises wired.

In conclusion, I should like to express my thanks to the Town Clerk of Worcester (Samuel Southall, Esq.), and to Mr. C. D. Taite, electrical engineer to the Southport Corporation, for their kindness and help in the preparation of this scheme.

BILLS BEFORE PARLIAMENTARY COMMITTEES.

NORTH METROPOLITAN ELECTRIC POWER BILL.

Mr. H. A. Brown presided over a Select Committee of the House of Commons to consider the Bill of the North Metropolitan Electric Power Supply Company. The Committee met first on May 24th and on several subsequent days. Mr. Littler, Q.C., appeared for the promoters of the measure, and the various local bodies in the North of London, through whose areas the company are asking for powers, appeared in opposition to the Bill. The Harrow Electric Light and Power Company also appeared by counsel in opposition to the Bill.

Mr. LITTLER, Q.C., in his opening speech for the promoters, said that the company which was promoting the scheme had been formed on the principle which had been laid down by successive Parliamentary Committees that the larger the works supplying a district with electricity, and the more varied the demands they had to meet, the better it was for the consumer, because the company would be able to supply cheaply and efficiently. The district proposed to be embraced by the company included the eastern half of the County of Middlesex, a considerable portion of the County of Hertford, and a small part of Essex. The districts scheduled comprised Enfield, Waltham Cross, St. Albans, Friern Barnet, Southgate, Hornsey, Wood Green, Hendon, Finchley, Harrow, and Wembley. In some of those districts there were light railways and tramways which were sure to be run in the future by electricity, and the area also contained a good many large manufactories which would, no doubt, be glad to get a good supply of electrical energy for power purposes, if it could be supplied on advantageous terms. The company, under the Bill, sought power only to deal with those people and authorities who had Parliamentary authority to sell electricity. The company would sell to them wholesale, and they would sell to the consumers. The only compulsory powers which the promoters asked for was power to open up the streets and roads for the purpose of laying down their mains. It would be within the power of the local authorities to dictate absolutely to the company the routes which the mains should take, and if they chose they could break up the streets and lay the cables, charging the cost to the company. In conclusion, Mr. Littler said that the scheme was in no way of a speculative character, but that it would be of the greatest possible advantage to the localities affected in supplying at a cheap rate electricity both for lighting and power purposes.

Mr. S. Z. DE FERRANTI gave evidence at considerable length in favour of the Bill. He explained that for manufacturers who only required power at certain times of the day, it was far more economical to take their supply from a company which had various loads than to establish small generating stations of their own. He anticipated that a number of tramway and light railway companies would find it advantageous to obtain their power from them. If that anticipation proved correct, the company would be able to supply power for lighting on very cheap terms, because they would have a considerable load factor throughout the day, and also in the evening. They would be in a position to supply power to local authorities at a reasonable price, who, in their turn, would be in a position to supply large or small manufacturers at a very much lower price than these manufacturers could supply themselves. As Mr. Littler had explained, the object of the promoters was to generate and transmit the power to those who would take it wholesale, and afterwards distribute it in detail to consumers.

Mr. BALFOUR BROWNE, Q.C.: So that instead of the local authorities and tramway companies each having their separate generating stations, and distributing the electric energy to the consumers, they would take their supply from the Power Company?—Yes, that is so. Continuing, witness said they had based their calculations on a 25 per cent. load factor derived from tramways, lighting and power purposes. As a commencement they proposed to lay down plant for producing 8,000 KW; but they only put the maximum demand at 6,000 KW., thus allowing 2,000 KW. for reserve. The estimated units generated would be 15,300,000, and the estimated units sold 13,000,000.

What is the estimated cost of the plant? £59,800 will be the cost of the plant necessary to transform the steam power into electrical energy. In addition, there is £80,000, the cost of the engines and generators; £16,000 for the switch gear, and £40,000 for lands and buildings brought up the total to £195,000. The mains and transformers would cost another £355,000, to which must be added £34,000 as the expenses incidental to the promotion of the company (including engineering fees, &c.), which made a gross total of £390,000. The works' cost would be £22,000. The total expenditure for generation and distribution would be £52,000, or just under 1d. per unit.

What is the price you propose to supply at?—Three-halfpence per unit, which we consider a very tempting price. On the assumption that we dispose of 13,000,000 units per annum, that will produce a gross revenue of £81,250. From this will have to be deducted the £52,200, the cost of generation and distribution, which will leave a net profit of £29,050, equivalent to 7 per cent. upon the capital, leaving £1,750 as balance to be carried forward. Continuing, witness explained that the system to be adopted was that known as the two-phase alternating current, which would be transformed down to the 500-volt continuous current required to supply the tramways. They proposed to have a third cable, in case of breakdown, so as to obviate any possibility of a district being cut off the supply. Each of the cables would be equal to the transmission of 2,000 H.P.

Replying to Mr. CLAUDE BAGGALLAY, Q.C., the WITNESS said it was correct to say that really the details of the scheme were the same as those of the promoters of the Durham Bill. Of course, their scheme was modified by the different circumstances of the two districts.

Mr. GEORGE CORBLE gave evidence on behalf of the Lea Conservancy Board in favour of the Bill, and said that the scheme would be of great benefit in developing the business of the River Lea, as it was likely to attract manufacturers to build factories on the banks of the river.

Mr. J. W. SWAN, F.R.S., the next witness, was examined as to the feasibility of the scheme, and gave it as his opinion that electricity could be transmitted with perfect safety as proposed by the promoters of the Bill. It was now possible to transmit economically over large areas electrical energy which had been generated at one large central station. In his opinion it would be a very much better and more economical arrangement to sanction such a scheme as the present promoters asked for, instead of establishing a number of small generating stations for supplying their own areas.

Mr. J. S. RAWORTH gave similar evidence, and said that the cost of distributing the electricity from a central generating station over large areas was very small, and he felt sure that local authorities would be able to supply consumers more economically if they first bought their bulk supply from a large company than if they erected generating stations of their own.

The Committee adjourned until June 19th.

LEGAL.

CROMPTON & CO. (*re* THE ELECTRICAL POWER SYNDICATE, LIMITED).

IN the Queen's Bench Division on Thursday last week, before Mr. Justice Wright and a special jury, the case of Crompton & Co. (*re* the Electrical Power Syndicate, Limited), came on for hearing. Mr. Bray, Q.C., and Mr. Mellor were counsel for the plaintiff company, and Mr. Terrell, Q.C., and Mr. Dunham for the defence.

Mr. BRAY said the plaintiffs, Messrs. Crompton & Co., were a well-known electrical manufacturing company, having large works at Chelmsford, and offices in London. The defendants, the Electrical Power Syndicate, was at present in liquidation, but the jury must not think it was insolvent, for the shareholders had had all their money returned, with a dividend of 100 per cent., and there were assets which would be sufficient to pay a further dividend of some 250 per cent. It was a company that had done its work, and was being wound up because it had done its work, and plaintiffs claimed to have a title to some of its assets. Messrs. Crompton and Co. claimed that having rendered large services in the promotion, and after the promotion of the syndicate there was an agreement made by which plaintiffs and other companies which had rendered similar services should have the right to be contractors to the syndicate for such electrical plant and machinery as they would in the ordinary course require. They had

even a greater increase.

The apparent anomalies in steam engine practice all arise

consider such an application, but if they did grant a loan it would have to be repaid in 10 years.

been refused these contracts, the syndicate had repudiated all liability, and plaintiffs asked for damages, which would represent the profits they would have made on their share of the contracts. Alternatively, they said that if there was no such agreement, they were entitled to be paid for services rendered. In 1896 a Mr. Addenbrooke, an electrical engineer of Wolverhampton, was proposing a scheme for having a central station in Staffordshire to supply electrical power to towns near Birmingham where there were many manufacturers needing it for their works. As the jury would be aware, there was between Birmingham and Wolverhampton an extensive manufacturing country and an enormous demand for power. Mr. Addenbrooke, in order to carry out his scheme, had to look out for some person to assist him—some person of high standing in the electrical engineering profession, and under those circumstances he was advised to apply to Mr. Crompton, who, he knew, was well known in the electrical world. Mr. Crompton was not able to be present at the trial, counsel explained, because he was away in South Africa with the Volunteer Royal Engineers Corps. However, Mr. Crompton and Mr. Addenbrooke had interviews and went into the matter in great detail. Mr. Crompton and a fellow director of his firm, a Mr. Albright, agreed to enter into the formation of a syndicate to carry out the idea. The company was incorporated on June 10th, 1897. The scheme was gone into in great detail, and ultimately it was arranged that Messrs. Crompton and Co., Messrs. Callender & Co., a cable construction company, and Messrs. Parker, an electrical engineering company in Wolverhampton, should be contractors to the syndicate. It was estimated that the total work to be done by these firms would amount to about £150,000, of which each was to receive as nearly as possible an equal share. On September 10th a minute was passed placing on record the arrangement made with the three firms, and it was also understood that they were to be the contractors for a new company to be formed. It was also provided that any disputes that might occur should be settled by arbitration, and that if the syndicate desired at any time to dispose of its rights, the contractors should receive one-tenth of the amount received. Then it appeared that the Midland Electric Supply Corporation was formed by the syndicate to work the provisional order, and it was agreed that if the Corporation took over the concern the syndicate was to pay to the contractors 15 per cent. of the money actually paid to it. After that another dynamo firm came in, and there were negotiations and other arrangements come to under which the plaintiffs should have received some £2,500 for their services. The fact, however, was that the syndicate sold to the third company without making any provision for Messrs. Crompton. A good deal of correspondence ensued (which counsel read), and plaintiffs' claim was that they were entitled to at least one third of the profit on the contracts for the machinery and plant for carrying out the scheme. There were minutes in the books of the syndicate——

Mr. TERRELL: We admit there is a minute in a book, but that does not amount to a contract.

Mr. BRAY said the defendant syndicate, after consulting with Messrs. Crompton who advised them as to a scheme, agreed to sell all the issued shares to the Midland Electric Supply Corporation through a Mr. Wynn, the nominal purchaser, for £16,000 without making any provision for Messrs. Crompton, and then they proceeded to divide the money, giving £4,000 to the directors.

His LORDSHIP: What have we to do with that?

Mr. BRAY said it showed that they provided for themselves first.

His LORDSHIP: Why should they not? If evidence is tendered on that point, I shall be obliged to exclude it. Did the Midland Corporation construct their works?

Mr. BRAY: They have not done so yet. They have asked us to tender, and we did, but they did not give it to us, and they have not given it to anybody else.

Mr. TERRELL: Because your tender was £20,000 above anybody else's.

Mr. MELLOR then read the affidavit of Mr. Crompton, head of the plaintiffs' firm.

Mr. Justice WRIGHT said it appeared that there had been members of three firms, Messrs. Crompton, Messrs. Parker, and Messrs. Callender, who made themselves directors of the syndicate, and made a contract that they should each have a third of the work and profits. It seemed to him that Mr. Crompton had not done more than look after his own interests. He asked Mr. Terrell what his points were.

Mr. TERRELL said he would submit, first of all, that there was no foundation for the action in law. The contract alleged against him was a verbal agreement made by a Mr. Albright, on behalf of Cromptons', before the syndicate which was sought to be charged with that contract was registered, and it was a contract that was outside the powers of the memorandum of association, and so could not be adopted after. It was not a contract to do work, but a reward for certain services rendered to the promoters by entering into a contract to make another contract if called upon to do so. It was, in fact, a contract to give them an option. It was *ultra vires* of the memorandum of association, and they had no right to make such a contract. Resolutions passed by a meeting of directors did not make a contract.

Mr. REEVES, general manager for Messrs. Crompton, gave evidence of the fact that Mr. Albright, a director, had reported to the board that he had put the contract with the syndicate in order.

Cross-examined: He would not say at what meeting that happened, nor could he find anything in the minutes.

Mr. BRAY, in reply to a remark of Mr. TERRELL'S, said that everybody appeared to have had money except his clients. Mr. Callender had had £700.

Mr. TERRELL said he had not.

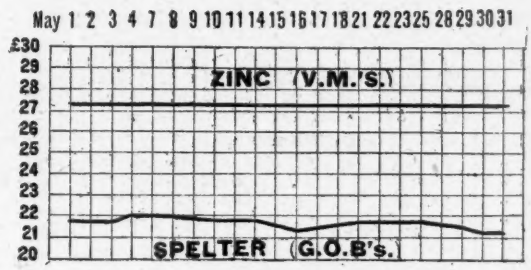
Mr. BRAY said the directors had voted to themselves £4,000.

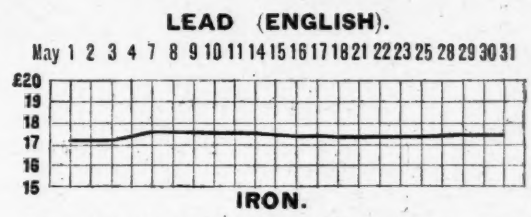
Mr. TERRELL said that was absolutely untrue. He, of course, made no accusation against his learned friend.

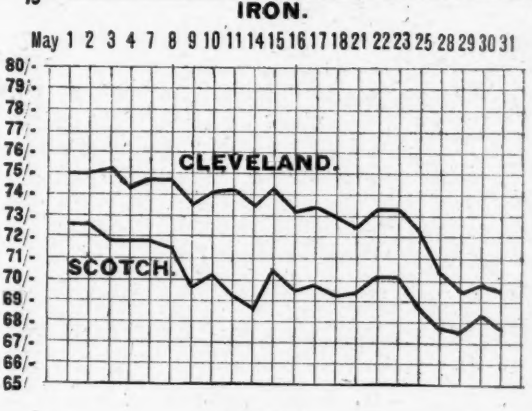
After some remarks from his LORDSHIP, counsel on both sides had a consultation, and as a result announced that terms had been arrived at under which the defendants were to pay plaintiffs £750 without costs.

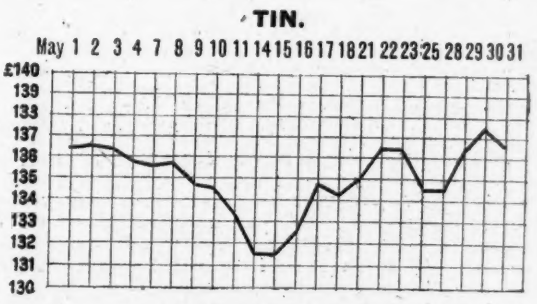
His LORDSHIP: I have no reason to question the propriety of that. The case was then withdrawn from the jury on the terms stated.

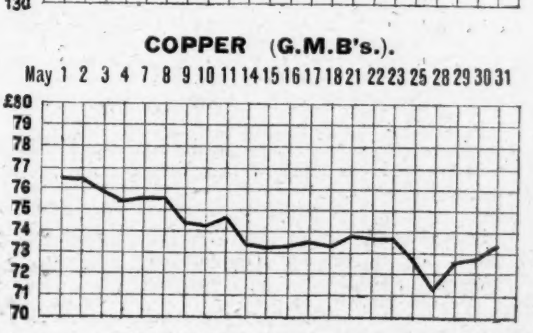
METAL MARKET.—Fluctuations in May











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nticipation proved correct, the company would be able to supply ower for lighting on very cheap terms, because they would have a

to be contractors to the syndicate for such electrical plant and machinery as they would in the ordinary course require. They had

TELEGRAPH FÊTES AT THE PARIS EXHIBITION.

One of the decisions of the Volta Centenary Congress of Telegraphists, held in June last, was to gather the delegates together again at a reunion in Paris to be held during the Exhibition period. The arrangements are now practically complete, and we are able to give the first English notice of the details of the programme. The celebrations are to extend from August 19th to August 26th, the period coinciding with the International Congress of Electricians. A strong committee has been formed, composed as follows :—

COMITÉ D'ORGANISATION DES FÊTES.

COMITÉ D'HONNEUR.

Presidents { Monsieur le Ministre du Commerce, de l'Industrie, des Postes et des Télégraphes (M. Millerand). Monsieur le Sous-Secrétaire d'Etat des Postes et des Télégraphes (M. Mougeot).

M.M. Lavy, Chef du Cabinet du Ministre.
" Cassel, Chef du Cabinet du Sous-Secrétaire d'Etat.
" Gody, Directeur de la Caisse Nationale d'Epargne.
" Bordelongue, Directeur de l'Exploitation Electrique.
" Barbarat, Directeur du Matériel et de la Construction.
" Blanqué, Directeur de la Comptabilité.
" de Laboulaye, Inspecteur-Général des Postes and des Télégraphes.
" Darcq, do. do.
" Wünschendorff, do. do.
" Perrin, do. do.
" Vasbender, do. do.
" Willot, do. do.

COMITÉ D'ORGANISATION.

President.—Mr. Ansault, Directeur de l'Exploitation Postale.

Vice-Presidents { M. Mio, Directeur des Postes and des Télégraphes de la Seine. M. Frouin, Directeur des Services Electriques de la Région de Paris.

Membres.

M.M. Joyeux, Receveur Principal des Postes de la Seine.
" Jacottey, Chef du Bureau de la Correspondence postale internationale.
" Stoullig, Chef de Bureau á la Caisse nationale d'Epargne.
" Blondiot, Directeur des Postes & des Télégraphes de la Marne.
" de Pydemarc, Directeur des Beaux. Ambts. de la Ligne du S.O.
" Meyrat, Inspecteur des Postes des Télégraphes de la Seine.
" Vivier, Inspecteur des Beaux Ambts. de la Ligne du Nord.
" Rabuteau, Receveur ppal. des Postes des Télégraphes á Bordeaux.
" Serres, Receveur des Bureaux de l'Exposition.
" Pierré, Chef du Poste Central télégraphique de Paris.
" Sins, Chef du Bureau de la Correspondance télégraphique internationale.
" Braive, Directeur des Postes and des Télégraphes de Seine & Marne.
" Villeneuve, Directeur des Postes & des Télégraphes de Seine and Oise.
" Sabourain, Inspecteur des Postes & des Télégraphes (Sces. électriques).
" Constant, Recr. ppal. des Postes & des Télégraphes à Marseille.
" Heugas, Recr. ppal. des Postes & des Télégraphes à Lille.
" Charvin, Chef du Bureau Central téléphonique de Gutenberg.
" Amiot, Cis. ppal. au Bureau télégraphique du Mtere. de l'Intérieur.

Secrétaire Général—M. Vidal de Lirac, Chef du Service Intérieur.
Trésorier—M. Ecarnot, Commis. principal des Postes et des Télégraphes au Beau. té égr. de la Bourse.

Secrétaires { M.M. Benanson, Rédacteur au 1er bureau du Personnel. " Dubois, Rédacteur au 1er bureau de l'Exploitation Postale. " Graux, Commis. principal au poste télégraphique Central.

An executive committee has been selected, and is composed as follows :—

President.—M. Frouin, directeur des services electriques.

Members.—MM. Stoullig, Vivier, Vidal de Lirac, Amiot, Meyrat, and Ecarnot.

The programme is as follows :—

1. Reception of foreign and French delegates at the Ministry of Commerce by the Organising Committee.
2. Visits of the delegates to the Exhibition, and the larger establishments of the administration.
3. Ball at the Ministry of Commerce given by the Under-Secretary of State (M. Mougeot).
4. Journey to Versailles and lunch.
5. Special performance at one of the subsidised theatres.
6. "Good-bye" banquet at the Exhibition.

It is also expected that a further fête will take place at the Hotel de Ville, and arrangements are now being made with the Prefect of the Seine with this object. Facilities will be accorded to delegates for travelling and admission to the Exhibition and other places in Paris.

The Marquis of Londonderry has granted permission to Messrs. C. H. Garland and C. E. Hall to be present at this reunion to represent the English telegraphists. The annual conference of the Postal Telegraph Clerks' Association, held at Newcastle-on-Tyne in March last, elected them as their representatives, and the Postmaster-General has now given them permission to carry out the duties of their position.

CORRESPONDENCE.

Electric Launches on the Thames.

Your note in the current issue, and your leader of May 11th, have indeed been of value and brought fruit, for I am at the moment engaged in preparing the details of a scheme for the adoption of electric boats for regular and rapid passenger service on the Thames, for one of the groups of financiers who now see an opportunity of establishing a profitable business by running a continuous service of comfortable boats all the year round at short intervals, similar to a first-class tramway service.

I must, however, take some credit to myself for awakening the interest of the *Daily Mail* and the general public, as I wrote a letter to the above journal some time before your issue of May 11th, and demonstrated the advantages of electric boats, including the points which you do not make, of the larger passenger capacity for the same sized boat when electrically driven as against steam, and also the far greater safety, owing to superior power of control vested actually in the captain's own hands.

In the electric boats which have been built on the "Callow-Eck" or "Vril" system, Mr. Cecil Callow and myself have both been agreeably surprised at the very economical and satisfactory results obtained with the storage batteries; we are able to gauge to a great nicety the mileage of the boat and the maintenance cost of the batteries, and can fairly say that there are now no unsolved problems in electric boat construction.

The inevitable time occupied in battery charging, we have now arranged, so that the boats can be practically in continuous service, by introducing interchangeable unit groups of cells with automatic connections, which can be lifted in or out; or else if suitable, and this is generally so in ferries, by coupling the boat to a constant potential supply by charging cables at each stoppage.

Justus Eck.

Chiswick, *June 2nd*, 1900.

The Protection of Insulated Wire.

After reading Mr. Sydney F. Walker's article, and Mr. Bathurst's reply, it seemed to me that something was wanting—that the authors had striven to get out of a groove and without success. Only Mr. Walker appeared to have started writing with the hope that something new would turn up, whereas Mr. Bathurst got inside his insulating conduit (which Mr. de Segundo so unkindly says he *seems* to be an advocate of), and was unable to find his way out.

Mr. de Segundo's letter carries us further, and although his arguments are not new, they cannot be too widely known. No systems however perfect, no regulations however uniform or severe, can be made a success without a proper scheme to suit the requirements of each case, without efficient inspection, and without careful testing. Insulating conduit may be an excellent thing in some cases, but it is not the universal panacea for house wiring. There are even times when the "bedstead tubing," which Mr. Bathurst so lightly dismisses, may be more useful. The moral I wish to point is, that if wiring firms would all insist (some do) on asking their clients to

employ a consulting engineer to advise and inspect, it would be better for everybody. Apart from the fact that the work would be done in a better manner, it would not be necessary to crawl under so far in order to disconnect plugs, to walk upstairs in the dark, or to get out of bed to turn on the light. No man thinks of adding a wing to his house without employing an architect, nor does he have new drainage installed without getting the advice of a sanitary engineer. To be "advised" by a wiring firm's foreman is to court careless work and inefficient application of the advantages of the electric light to the house which has to be wired.

V. Zingler.

London, *June 5th*, 1900.

INDISPENSABLE ACCESSORIES OF ELECTRIC TRACTION.

By HENRY E. P. COTTRELL, A.M.I.C.E.

(*Continued from page* 908.)

In the higher rated instruments, an auxiliary break is provided in addition to the final carbon break. These instruments, classed in accordance with their rating and type, are given in the following table :—

In the extra standard switchboard types which are designed for circuits of the very largest capacity, the currents are carried through laminated contacts in series with the actuating coil of the instrument. The main break is between the laminated contacts, and is followed almost simultaneously by the auxiliary break which is in shunt with the main contacts, and is itself protected by a final carbon break of ample capacity, and the proportions are such that these instruments can be closed with no greater effort than that required to close an instrument carrying 50 amperes only. A special type of circuit breaker is also constructed with double pole and double coil which opens both sides of a circuit when overload occurs in either ; these are rated from 80 to 600 amperes with minima of 60 to 450 and maxima of 120 to 900 respectively. Where the voltage release is provided the coil belonging to this is placed in shunt between the two poles of the circuit, and the underload release is arranged to open automatically when the current drops to zero, and is used when storage batteries are worked in series with the generators. Single-pole circuit breakers are also made for alternating currents of 1,100 volts to 5,000 volts with a rating of 5 to 200 amperes and over, so that these instruments cover the whole possible field of circuit-breaker practice.

The I.T.E. circuit breakers act very fairly well as lightning arresters, the heavy coil acting as a choke, but it is far safer to add a special lightning arrester to each switchboard, and no other type comes anywhere near the sensitive type of fuse known as the "Ajax" lightning arrester previously described in connection with car accessories, and this should be considered as an indispensable accessory of every switchboard. In stations situated where there is a liability to heavy thunderstorms, it is often necessary to protect a switchboard by as many as three banks of lightning arresters. In such a case two are placed on the trolley side of each feeder circuit and one on the trolley side of each generator. One set is generally of the well-known water-tank pattern and the other two of the "Ajax" type.

For electric traction purposes all switches have to be of the knife-edge quick-breaking type, with single, double, or triple-poles, and single and double-throw, according to the special service to which they are adapted. They are fastened like the circuit breakers to the switchboards by either top or back connections, and they are all fixed on enamelled slate or marble bases of various dimensions. Many designs are in use varying to an indefinite extent in minor details, but all substantially the same in principle, the copper knife edges being held back by very powerful springs, and the actual contact not being broken between the knife edges but between special arrangements of copper springs and carbon rods which are easily replaceable at any time if burned through. All switches for heavy currents are protected by

TABLE OF I.T.E. CIRCUIT BREAKERS.

Description.	Circuit.	MIDGET. Direct or alternating current. Junior. Volts.	Actual rating.	Lowest.	Highest.	Senior. Volts.	Actual rating.	Lowest.	Highest.	STANDARD SWITCHBOARD. Direct current. Ordinary. Volts.	Actual rating.	Lowest.	Highest.	Extra. Volts.	Actual rating.	Lowest.	Highest.	Remarks.
Single coil single pole double break.	Two-wire Two-phase	500 or under	4 to 24	3 to 18	6 to 36	500 or under	5 to 200	4 to 150	8 to 300	500 or under	80 to 1,250	60 to 1,000	120 to 1,800	500 or under	1,250 to 3000 also 4,000 to 10,000	1,000 to 2,500	1,600 to 4,000	For overload only, or overload and underload; no voltage release. With front or back connection or both.
Double pole quadruple break.		250 or under	Do.	Do.	Do.	250 or under	30 to 200	25 to 150	45 to 300	250 or under	200 to 1,500	150 to 1,250	300 to 2,250	250 or under	2,000 to 8,000	...	...	
Triple pole sextuple break.	Three-wire Three-phase	250 or under	Do.	Do.	Do.	250 or under	Do.	Do.	Do.	...	...	...	...	...	...	...	...	

3. Ball at the Ministry of Commerce given by the Under-Secretary of State (M. Mougeot).

firms would all insist (some do) on asking their clients to

safety fuses or cut-outs which prevent currents with pressures exceeding certain designed limits from passing through the switches and injuring or destroying the contacts. The "Anderson" double-pole double-throw knife switch is made in ratings from 35 to 3,000 amperes; similar switches are made with single and triple-poles, single and double-throws. The "Hancock" quick-breaking switch (triple-pole) is made for smaller range of rating (25 to 500).

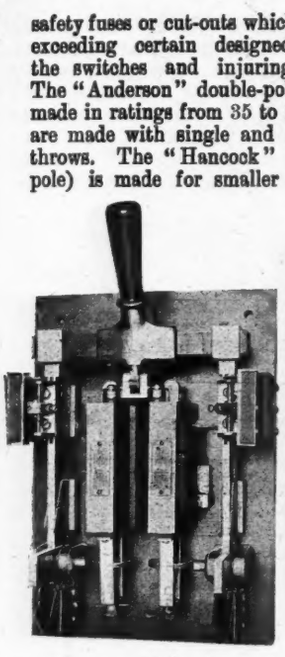


FIG. 100.—I.T.E. CIRCUIT BREAKER. ALTERNATING CURRENT D.P., DOUBLE COIL. 300 AMPS. 600 V.

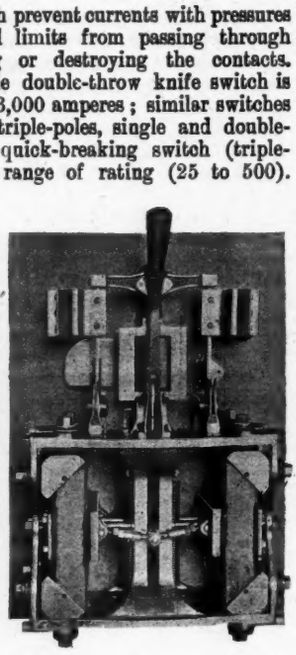


FIG. 101.—I.T.E. CIRCUIT BREAKER. STANDARD SWITCHBOARD, DOUBLE-POLE. 3,000 AMPS. 250 V.

The "Ajax" switches have even a greater range than the "Anderson" make, as 10-pole switches of this type with a rating of 7,000 amperes at 500 volts (= 4,600 E.H.P.) weighing over 400 lbs., having been constructed. Single-pole switches of this type have usually a rating of from 35 to 3,000 amperes, double-pole, of from 35 to 600, and triple-pole of from 150 to 500 amperes.

An approximate rule for calculating the weight of switches from the rating is the following:—For single-throw switches $\frac{\text{rating}}{10} \times \frac{2}{9}$ = weight of single-pole switch in lbs., $\frac{\text{rating}}{10} \times \frac{4}{9}$ = weight of double-pole switches, and $\frac{\text{rating}}{10} \times \frac{6}{9}$ = weight of triple-pole switches. To obtain the respective weights of double-throw switches add one-third to each of the above. The average cost can also be approximately calculated from the rating as follows:—For single, double and triple-pole single-throw switches multiply the rating by 2, 3 and 4 respectively, and the result will be the cost in pence, while for double-throw switches multiply the rating by 5, 9 and 13 respectively to obtain the same result.*

The measuring and registering instruments mounted on a switchboard consist of ammeters, voltmeters and wattmeters, or potential, current and work indicators and registers. All these instruments are based upon the principle of Deprèz d'Arsonval's well-known reflecting galvanometer, and vary chiefly in the arrangements of the scales and the registering device which is added. The best forms are made so that they can be used equally well in direct or alternating current circuits. The difficulty in the latter case being involved in the elimination of all self-induction and to obtain a direct indication of the square root of the mean square (effective or virtual) potential or current strength. The principle on which this difficulty was overcome simply consists in the substitution of special forms of non-permanent magnets for permanent ones connected so as to counteract the self-induction in one portion by contrary self-induction in another. The integration of the repeated and alternating pulse is mechanically effected by methods which are too well known to require description, and registration is also effected by similarly well-known devices.

The "Weston" model of these instruments has been in use for several years on both sides of the Atlantic, and is well and favourably known. The "Keystone" model, has, however, been steadily making its way in the favour of electricians, and presents many points of difference and probable superiority over the first-mentioned model. Both are what are known as dead-beat instruments. In the Keystone models the dials are illuminated by lamps fixed under a hood so as to cast no shadows, and easy to read by; the scales are very open round the normal working point. Both potential and current instruments are calibrated to the same degree of accuracy, and their scales adjusted by standards in the laboratory, so that they are equally reliable (which is not usually the case); they are not affected by external magnetism or changes of temperature, all moving parts are on jewelled bearings, and they are contained in dust-proof cases, so that they are not subject to change or deterioration of any kind. Among the various types of these instruments for switchboard service are: Differential instruments for indicating the difference of potential between two or more generators running in parallel or on the same set of bus bars; polarity and detector galvanometers for determining leakage in the return circuits are also made of similar types to the preceding. The voltmeters are made of various sizes with working ranges of from 1 to 600 volts, and scales divided in $\frac{1}{10}$th to 10-volt divisions, while ammeters run from 5 to 10,000 amperes in size, with scales with divisions of $\frac{1}{10}$th to 200-ampere divisions, and the wattmeters from 300 to 120,000 watts divided into 2 to 1,000-watt divisions. For alternating current circuits milliammeter instruments are also constructed with corresponding scales. These are such delicate and sensitive instruments that it is necessary to take the mean of two readings with the current flowing in opposite directions. This precaution is, however, distinctly preferable to the introduction of a mechanical brake to produce the same dead-beat readings which the instruments for heavier currents of this make possess, without this objectional adjunct.

FIG. 102.—I.T.E. UNDERLOAD S P. 400 AMPS. 550 V.

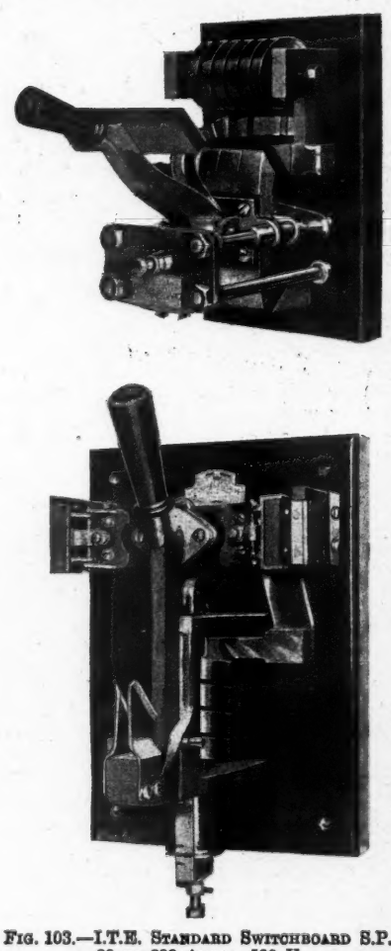


FIG. 103.—I.T.E. STANDARD SWITCHBOARD S.P. 80 TO 600 AMPS. 500 V.

* At the present high cost of copper, this gives results which are too low.

A special instrument, which is often of the greatest use as a permanent adjunct to every leakage panel, is a galvanometer and ground detector for constant potential circuits. This is designed to indicate the presence of ground on a line, and is made for use with both direct and alternating currents. For direct current circuits the scale has a central zero and there are three binding screws, the central screw for connection with the ground or return circuit, the other two with the positive and negative sides of the line. For alternating current circuits the zero is at the left hand of the scale and there are two binding screws, one for connection with ground, the other with either side of the line. Where the voltage of the primary is very high, then the connection should be with the secondary of a special transformer.

The function of the rheostat is to introduce a momentary resistance in the circuit with the object of reducing its potential to the prescribed working limits whenever from some cause the potential is run up beyond those limits. It therefore fulfils in an electrical plant functions analogous to those of a governor in a steam plant; in other words, while the first prevents the destruction of the plant through being run at speeds for which it was not designed, the other prevents the destruction of the electrical plant through being run at pressures for which it was not constructed.

The conditions which a satisfactory service rheostat should comply with are the following:—

1. It should dissipate a maximum of heat in a minimum time.
2. It should be fireproof, and no combustible material should enter into its construction.
3. It should be durable, and not subject to deterioration from oxidation or electrolysis.
4. It should be compact and simple.
5. It should be unaffected by heat, cold, acids, alkalies, oils, and other chemicals.
6. It should be unaffected by vibration.

The passage of heavy currents through a resistance must necessarily generate great heat, and as the specific resistance of a substance varies considerably with its temperature, the problem to be solved in the construction of a satisfactory rheostat was to provide adequate means for rapid cooling without at the same time in any way impairing the insulation of the rheostat coils. To afford a ready means of rapid cooling it is necessary, in the first place, that the surface of rheostat coils should be made as extensive as possible relatively to their sectional area. For this reason it is preferable to make the material composing them into flat ribbons and not cylindrical threads; as in the former the ratio of surface to sectional area can be increased to any desired extent, while in the latter it remains constant and is independent of the dimension of the diameter of the thread; (2) that the surface should be, on the one hand, as freely and extensively as possible in contact with the air, and on the other, in absolutely insulated contact with a relatively large mass of metal possessing a very high specific heat that shall assist in the process of rapidly cooling. The first desideratum is complied with by making the ribbon of the coils into closely reflexed whorls and attaching it by one edge to a heavy cr st-iron plate. These plates will dissipate continuously 5 watts per square inch of one surface and a $10'' \times 10''$ plate = 100 square inches will dissipate 500 watts. The difficulty was to find a substance which was a good insulator for electrical purposes and at the same time not a bad conductor of heat. This material was found to be an enamel, closely resembling that with which iron culinary utensils are coated. This, as everyone knows, is not a bad heat conductor, but it is not equally well known that it is a most efficient insulator for electrical purposes, and it has the further advantage of cementing one conductor to another while completely insulating them, and of being absolutely moisture proof, and practically indestructible. A thin wall of this enamel, thinner than that on an ordinary kitchen utensil, will completely withstand an alternating current of 2,000 volts. The production and application of special enamel to electrical accessories to meet the requirements of high and permanent insulation, has been due to the Ward Leonard Electrical Company, of Bronxville, New York, U.S.A.

Desiderata 2, 3, and 5 are completely complied with, as this enamel is wholly unaffected by the temperatures to which it is subjected in normal rheostat use, these being not so high as that to which it is subjected in the process of manufacture; it is also absolutely non-combustible and non-oxidisable, and unaffected by chemicals.

(To be continued.)

SOME PROPERTIES OF SUPERHEATED STEAM.

In a recent paper communicated to the Royal Society by Prof. Osborne Reynolds, some experimental investigations of the thermo-dynamical properties of superheated steam are recorded. Regnault's classical experiments on steam were made on steam drawn upwards from a boiler, any moisture being separated by gravity. As the method was open to some doubts as to its accuracy, further researches seemed desirable to fix the point. As saturated steam is wiredrawn by free expansion through small orifices, if the pressure be reduced sufficiently, the steam will be actually superheated by this process, and with an adiabatic flow, the energies on the two sides of the orifice will be equal. Hence if the energy of motion be made sufficiently small, this energy will exist as heat, and assuming the steam to be of the quality used by Regnault, the total heat of gasification of the superheated steam when wiredrawn will be known from 32°. Hence if we observe the pressures and temperatures in superheated steam, wiredrawn from definite initial saturated conditions, a simple calculation will give the values of the specific heat at constant pressure of the superheated steam.

In the author's experiments adiabatic flow was obtained through orifices in plate glass. The temperature and pressure of the saturated steam is taken, and the steam drawn upwards to the orifice, and after wire drawing, its temperature and pressure are again taken with a thermo-electric junction immersed in the steam. The results obtained show that gravitated dry saturated steam has only one condition as to its dryness, and the total heat of evaporation thus found agrees with the results of Regnault. It also appears that steam thus obtained has not the maximum density at that particular pressure and temperature, there being still an effect as of certain suspended moisture remaining in the steam which is capable of being dried out at the same temperature before superheating begins. There are many obscure properties in all gases, especially at and near their critical temperatures and pressures. These have been more often suspected than explained, and this particular fact emphasises the opinions of some steam engineers that steam at any temperature of saturation, $x°$, is drier when it has been produced from superheated steam at a temperature of, say, $x + 20°$, than when produced from water and steam at, say, $x - 20°$. In the one case the temperature of saturation has just been obtained, whereas, in the other case, probably all the double molecules have been put into a state of full kinetic energy, and all separated into more fully energised single molecules, and though at the same temperature, they really possess more kinetic energy or heat.

Under ordinary pressures and temperatures, Prof. Reynolds does not find any indications of the state of perfect gaseousness even approximately, and Rankine's formula, $\text{H} = \text{H}_0 + c\,(\text{T} - 32)$ for the total heat of gasification, H, of superheated steam at a temperature, T (H_0, being latent heat of formation from 32°), could not be applied to superheated steam, though intended by its author for such a condition of perfect gasification. The mean specific heat of steam at constant pressure shows a wide range in its value for different temperatures. Thus at atmospheric pressure the mean $\text{K}\,\rho$ between 230° F. and 246·5° F. was 0·4317, and between 295° and 311·5° it was 0·6482. The specific heat $\text{K}\,\rho$ was found to be independent of the pressure, but to vary nearly as the fourth power of the absolute temperatures.

Denoting the cooling effect of free expansion by $c = \frac{\delta\theta}{\delta p}$, the following thermo-dynamically correct formula enables a check to be made of experimental results:—

$$\frac{\delta}{\delta p}\,(\text{K}\,\rho) = -\,\frac{\delta}{\delta \text{T}}\,(c\,\text{K}\,\rho),$$

for if $\text{K}\,\rho$ is independent of the pressure, then $c\,\text{K}\,\rho$ must be independent of the temperature, and it was experimentally shown to be independent of both temperature and pressure.

Integrating Thomson's formula $\frac{d\,\text{T}}{\text{T}} = \frac{d\,v}{v + c\,\text{K}\,\rho}$ for the cooling effect c, and using the experimentally determined values of the product $c\,\text{K}\,\rho$, values of the specific volumes v of superheated steam at various pressures and temperatures were calculated, the lower limit of integration being taken from known data in the saturated condition of steam. Hence it follows that for any gas, in which $\text{K}\,\rho$ is independent of the pressure, as is the case for many gases, the last formula may be put into the form $\frac{v + c\,\text{K}\,\rho}{\text{T}} = f\,(p)$, where $f\,(p)$ denotes any function of the pressure. The variation of the specific heat with temperature is a property of most gases, though it is a property that has received extraordinarily little recognition, and this has led to a good deal of misconception in regard to possible temperatures due to combustion, and probably to a good deal of bad theorising on the subject of internal combustion motors. Those who are more specially interested in the subject of the thermal properties of gases may study the monumental work of Berthelot, or his various

papers in *Les Annales de Chemie et de Physique*. Many physicists have added their quota to the hidden mine of knowledge; but, somehow, the theory of dissociation, itself correct within limits, has been stretched to do a double duty to the exclusion of a proper recognition of the variation of specific heat.

BUSINESS NOTES.

Electrical Wares Exported.

Week ending June 6th, 1899.		Week Ending June 5th, 1900.	
Adelaide	Value £60	Alexandria	Value £318
„ Teleph. mat.. ..	95	Amsterdam	305
Amsterdam	58	Bangkok	74
Bangkok	183	Beira. Teleg. mat.	101
Bombay	171	Bombay	291
Boulogne	62	„ Teleg. mat.	49
Buenos Ayres. Teleg. mat. ..	150	Boulogne	20
Calcutta	716	Buenos Ayres	217
Cape Town	3,505	„ Teleg. wire	54
Colombo	15	Calcutta	286
Durban	1,915	„ Teleg. wire ..	507
„ Teleg. mat.	134	Cape Town	281
East London	75	Chinde	124
Fiume	100	Colombo	110
Flushing	10	Copenhagen. Teleg. mat. ..	104
Hamburg	140	Durban	74
Hiogo	340	Gibraltar. Teleg. mat.	25
Hong Kong	1,075	Gothenburg	11
Launceston	35	Hamburg. Teleg. mat.. ..	400
Madras	18	Hankow	20
Malta..	22	Hiogo	90
Melbourne	303	Lyttleton	75
„ Teleg. mat. ..	1,166	Madras	370
Montreal	70	Ostend	350
Ostend	15	Riga	52
Penang. Teleg. mat.	123	Rio Janeiro..	30
Port Elizabeth	322	Rotterdam. Teleg. wire ..	38
Rotterdam	20	Rouen	76
Santiago (Chili)	54	St. Petersburg	480
Shanghai	122	Shanghai	715
Singapore	47	„ 25 tons old teleg. wire	—
„ Teleg. mat. ..	484	Singapore. Teleg. mat.. ..	482
St. Petersburg. Teleg. mat. ..	80	Sydney	779
Stockholm. Teleg. mat. ..	19	„ Teleg. mat.	1,910
Sydney	955	Tokio..	38
„ Teleg. mat.	193	Valparaiso	119
„ Teleph. mat.	1,805		
Tientsin. Teleg. mat.	1,190		
Wellington	215		
Yokohama	148		
Total ..	£16,205	Total ..	£8,855

Foreign Goods Transhipped.

Hamburg. Elec. lgt. apps.	Value £50	Rio Janeiro. 25 tons teleg. wire	
		Stockholm. Telep. ..	Value £70
Total ..	£50	Total ..	£70

Acetylene Gas Lighting in India.—The railway station of the ancient and holy Indian city of Benares is to be lighted by acetylene gas. The system employed is the "Thorscar" patent, the contract having been given to Messrs. Lockerbie, Limited, of Birmingham. There will be a total of about 200 lights employed to illuminate the station and approaches.

Bankruptcy Proceedings.—A receiving order has been made on debtor's own petition against A. W. Hirst, electrical engineer (Hirst & Co., West Croydon).

The *Manchester Courier* says that on 1st inst. a receiving order was made in the Manchester County Court against George Herbert Bentley, 63, Cross Lane, Earlestown, carrying on business as an electrical engineer at 8, Grafton Street, Earlestown. The first meeting is arranged for June 15th at Manchester, and the public examination for July 6th at Warrington.

Books Received.—"Traction Electrique," by Eric Gerard. Paris: Gauthier-Villars, 1900. 3 fr. 50 c.

"Proceedings of the Thirty-third Annual Convention of the American Institute of Architects," 1900. Washington, D.C.:—Gibson Bros.

Catalogues and Lists.—Messrs. E. F. Moy, Limited, send us a circular sheet of their distributing fuseboards.

The B.T.H. Co.'s price list, No. 32 (May 21st), will probably be useful to many municipal electrical engineers and tramway men, for it deals with overhead line material and gives numerous illustrations and particulars of same.

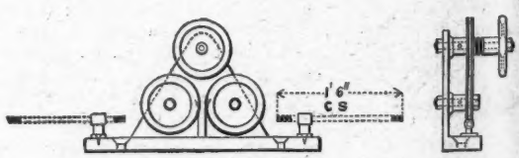
Messrs. Rowland Carr & Co., ironfounders, &c., of Lime Street Square, E.C., send us a wall hanging card showing electric light and traction castings, such as lamp and trolley posts, switch pillars, conduits, junction boxes, &c.

The Copper Market in May.—The last issue of Messrs. H. R. Merton & Co.'s statistical circular shows that stocks have gained 1,800 tons during the month of May, while prices have fallen £3 10s. per ton, this set back having occurred in the early portion of the month. During the latter half of May a gain of 2s. 6d. per ton in the price of G.M.B.'s was registered, and on May 31st this stood at £73 5s. as compared with £76 15s. on April 30th last. The total supplies during May have amounted to 25,240 tons, which is 3,700 tons above the average supplies during the last 12 months. North America is again responsible for the greater portion of this gain, having shipped 13,431 tons of copper to European ports as compared with 6,625 tons in May, 1899, and an average of 11,500 tons for the 12 months ending May 31st, 1900. The shipments from "other countries" amount to 5,169 tons, as compared with an average of 4,170 tons for the whole year. Chili shipped 2,600 tons to Europe during May, a gain of 600 tons on the average for the 12 months, while the shipments from Spain and Portugal and from Australia have been about the average. During May 675 tons of "Standard" have been shipped to North America, making a total of 13,137 tons for the 12 months. The increase in the shipments from North America to Europe has, however, now more than balanced this total. The stocks of copper at English and French ports, or afloat thereto, on May 31st were 29,204 tons as compared with 27,475 tons on April 30th, and 30,156 tons on May 31st, 1899. The deliveries during May were 22,836 tons, and adding the amounts shipped to America, the total consumption amounted to 23,511 tons.

Electric Driving in a Bleaching Works.—A beautifully illustrated pamphlet has been published by Messrs. A. J. King & Co., bleachers and finishers of Macclesfield, in connection with their Paris Exhibition exhibit. The pictures show the works and their machinery, including the electric lighting and power plant. It is believed that these are the only works in the United Kingdom where all the principal machinery from the grey room to the packing room is electrically driven. The electrical plant includes an Edison-Hopkinson dynamo (350 amps. at 105 volts.), supplied by Mather and Platt in 1896, and driven by a large water-wheel; and a combined engine and dynamo supplied by the same firm in January this year. This set has a capacity of 1,200 amps. at 105 volts. It supplies current to 30 motors varying from 1 to 30 B.H.P., and to incandescent lights throughout the works. Other photographs show electric motors driving a circular sewing machine at work upon grey cloth for the kiers, motors driving washing machines, pumps, squeezer, winces, &c., in bleach croft, also others driving dyeing machines, "Blackman" fans and finishing mangles in the finishing room. The plaiting and measuring machines are driven by a shaft actuated by an electric motor in a room below.

Fire.—We are informed that a fire which occurred at 82, Victoria Street on 31st ult. spread to the laboratory of the Nernst Electric Light Company, Limited, and did considerable damage. Nearly all the special apparatus was destroyed, and delay must necessarily occur before it can be replaced. The company has already started work again, and it is believed that this check to the development of the Nernst lamp industry will not delay the work seriously.

Improvements in Means for Straightening and Straining Wire.—In winding bobbins for electro-magnets and other apparatus, it is usual to draw the wire from the supply drum or coil through a tension device whereby it is strained. The object of the invention which we now describe is to prevent the wire becoming damaged owing to its fouling or to its being abruptly bent during the operation, for which purpose it is, according to this invention, passed through one or more flexible tubes which serve to straighten and guide the wire passing through it or them. In one arrangement, a tension device comprising three grooved pulleys arranged triangularwise in a suitable frame and one of which is braked by an adjustable spring washer bearing against its boss, is provided with receiving and delivering guide tubes, which respectively direct the wire to the said pulleys, around which it passes, and from the pulleys to the bobbin on which it is being wound. Each guide tube consists of a copper or other wire spiral, the pitch of whose coils is such that the guide tube forms a flexible



s, Copper spirals.

compression spring; each spring guide is held in position by a gripping or clamping support which may be secured to the frame of the tension device and may conveniently grasp the guide towards that end which is nearest the pulley to which it delivers or from which it receives the wire, as the case may be. Such a guide will approximately conform to convolutions which may accidentally occur in the wire and will tend to straighten them out; should it fail to do so and should it catch in a convolution or kink of the wire, it will become compressed as the wire continues to be wound on the bobbin, and will thus obviate excessive tension being put on the wire before the operator has time to stop his machine, thus preventing damage to the wire and delay in winding. The flexible compressible guide tubes may, in some cases, be formed of other material than metal, such, for example, as india-rubber. The appliance is made and used by Messrs. Mavor & Coulson, Limited, of Glasgow.

Inspection Chambers and the London Building Act.—An important point has been raised under the London Building Act which affects all electric lighting authorities in the metropolis. It appears that the district surveyor summoned the Whitechapel District Board for constructing inspection chambers in the streets without first notifying and obtaining his sanction, and that the magistrate decided against the Board, which was fined. At the same time he expressed his willingness to state a case for the High Court. A letter embodying these statements was placed before the

Shoreditch Vestry on Tuesday, when the Whitechapel Board inquired whether the district surveyor for Shoreditch, where there are over 1,000 inspection chambers, had acted in a similar manner. During the discussion it was elicited that no action had been taken in Shoreditch, but in view of the importance of the question, it was resolved to assist the Whitechapel Board in any steps it might feel justified in taking in the matter.

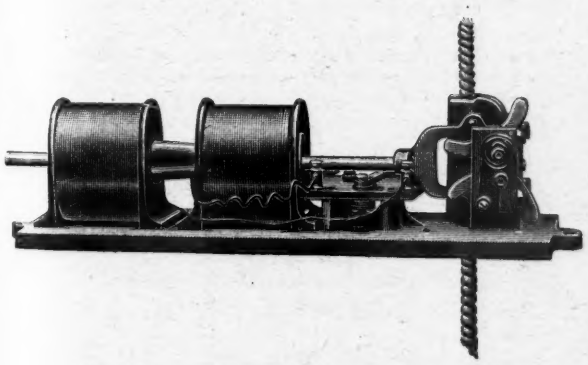
"John Bull" Engines.—Messrs. E. R. & F. Turner, of Ipswich, send us a descriptive price list of their new "John Bull" steam engines, which have been designed "to meet the existing demand for a fairly cheap small motor to work at a moderately high pressure." The "John Bull" is claimed to be entirely self-contained, and to have ample strength and large wearing surfaces throughout; and, what is a matter of extreme importance, the makers "will always hold a good stock of all sizes of these engines." Among those described and illustrated in this list are the undertype semi-fixed engines, detailing those of from 6 to 16 N.H.P., and the Turner-Hartnell automatic expansion governor, and the combined engine and vertical boiler. A separate circular gives a copy of the report of a test upon a Turner girder-type compound condensing engine and multitubular externally fired boiler working in a Witwatersrand gold mine. The performance of the engine is given as follows:—

Average indicated H.P.	173·4
Water used per H.P. per hour, including that condensed in jackets and lost by radiation between boiler and engine..	18·6 lbs.
Coal consumption per I.H.P. per hour (inferior Transvaal coal)	3·47 lbs.
Equivalent consumption in Welsh coal	2·12 lbs.

Meldrum's Refuse Destructors.—Messrs. Meldrum Bros., Limited, of Manchester, London, &c., have recently received a number of important contracts for their refuse destructors, among the latest orders placed with them being those for Heywood (to be erected and the power used at the Sewage Works), and Barrow-in-Furness, where the destructor and power plant will be used in connection with the electric lighting of the town. Others they are now engaged upon are those for Bangor, Nelson, Lancaster, and Wrexham, in connection with electric lighting, and at Bolton in connection with sewage works.

Reduction of Capital.—On July 7th Mr. Justice Kekewich will consider a petition presented to the Court for the confirmation of a special resolution passed on April 25th reducing the capital of the Crystal Palace District Electric Supply Company from £100,000 to £74,272 12s., by cancelling 18s. per share upon 28,586 £1 shares.

Safety Clutch for Lifts.—The clutch which we illustrate below has been designed to obviate lift and hoist accidents, but it also acts as an arrangement for automatically locking lift gates or doors without interfering with the working of the lift. It is electrically controlled either from battery or street main. To fit the apparatus to any existing lift does not involve structural alterations. The lift cannot be started while the door is open, and this, it will be readily understood, is an important feature removing a constant source of danger. The illustration shows the device with the



starting rope seized. This action is maintained while the door is open, and owing to the construction of the grip, it is impossible to pull the rope in either direction, and also it effectively prevents a lift worked by hydraulic power creeping away from the floor. When the action is reversed and the rope is released by suitable switches which are controlled in opening or closing the door or gate, the machine is thrown in or out of action, and an electrical contact made through the cage automatically locks the door or gate which can only be opened from inside; when the cage has left the floor it is impossible to open the door. The clutch is being introduced by the General Electric Company, Limited, under the "Bush-Jenkins" patent No. 20,615 of 1899.

Trade Announcements.—Mr. J. Burns, supplier of "Delaware" vulcanised fibre sheets, &c., has removed from 15, Long Lane, E.C., to larger premises at 76, Little Britain, E.C.

Mr. J. Frankenburg, Salford, Manchester, informs us that he has appointed the Accessories Manufacturing Company, of 26, Shaftesbury Avenue, as his agents for London and district. The offices and stores at 128A, Queen Victoria Street will be retained, and a stock will be kept at both addresses. The extra plant put down in the new building on the site of the old Salford Castle is fully employed, and further additions are contemplated to cope with the increasing demand. Mr. Frankenburg emphasises the fact that all his cable is made in Manchester, a statement we can bear out from our own knowledge. The test room is exceptionally well equipped with instruments of the newest and most accurate types, and under the management of Mr. H. E. Mabbs every effort is made to maintain a high standard of quality.

Messrs. W. T. Glover & Co., Limited, announce that their new address is W. T. Glover & Co., Limited, Trafford Park, Manchester.

ELECTRIC LIGHT AND POWER NOTES.

Barking.—A recent meeting of the Urban Council discussed the increase which has been made in the charges for electricity.

Bexhill.—On Tuesday last week Mr. John Money, foreman engineer to the contractors of the electric lighting works, was severely injured through, it is stated, some stone falling upon his head.

Blackpool.—Mr. R. C. Quin, the borough electrical engineer, presented his estimates for the present financial year at last week's meeting of the Committee. The recent abnormal advance in the price of coal has had the effect of reducing the profits of the electricity department. Mr. Quin's original estimate of profit for the year ending March last was £2,300, but as a matter of fact only £1,170 was realised. The price of coal had most to do with this, of course, but then the reduction of 1d. per unit meant a loss to the department of £1,500. Mr. Quin estimates that for the present year the gross profit will be £9,662. Interest and sinking fund charges, however, will absorb £7,477, leaving a net profit of £2,200. The capital outlay is over £140,000. It is said to be quite evident that if coal continues at its present price much longer a revision of the charges for electric current will be absolutely necessary.

Bridgend.—The District Council recently sold its provisional order to the English Industrials Company. Protracted correspondence took place, and the company eventually agreed to terms. At last week's Council a letter was read from the company expressing willingness to proceed with the agreement. It was decided that if the company could satisfy the Local Government Board within a month of their *bonâ fides* the Council would send on the necessary documents. A company, to be known as the Bridgend Electric Light and Power Company, will be formed to carry out the work.

Cape Town.—The *British South African Export Gazette* says that during this year 100 electric lamps are to be added to the street lighting here.

Dewsbury.—The Dewsbury Town Council has received a letter from the Yorkshire Electric Power Company, stating that it is intended to promote a general electric power scheme for the manufacturing portion of the West Riding somewhat on the lines of the Lancashire electric power scheme now before the House of Commons, and suggesting that the Dewsbury Corporation might deem it worth while to consider the advantage of having a supply of electricity in bulk from the company. The Council does not favour the scheme.

Dudley.—The Railway, Tramway and Electric Lighting Committee of the Town Council have recommended that the Corporation shall put in the wires to premises where the electric light will be used, free of cost, and they propose to borrow £10,000 to meet the outlay. The Committee also recommend that consumers shall have the option of being supplied at the rate of 5d. per unit throughout, or at the rate of 6d. per unit for two hours a day and 1½d. per unit afterwards, and that no rental be charged for meters. They further recommended that the offer of the British Westinghouse Company to sell to the Corporation the engine and dynamos, hired to the Corporation, for £1,360, less the sum already paid on account, be accepted.

Germany.—The Baden State Railway authorities are erecting a large central power station at Rheinau for the supply of current for lighting purposes to a large number of railway stations, &c., in the neighbourhood.

Isle of Wight.—The County Council is opposing the use of overhead wires for electric lighting in the Freshwater district.

Italy.—La Società Ferrorie e Tramvie Elettriche Varesine has decided to put down a plant to utilise the water-power of the Giona stream for the generation of the electrical energy necessary for the operation of the Varese-Luino electric tramway and for lighting and power purposes. Three large turbines and alternators of 500-H.P. each are to be put down, the contract for the electric installation having been placed with Messrs. Brioschi, Finzi & Co., of Milan.

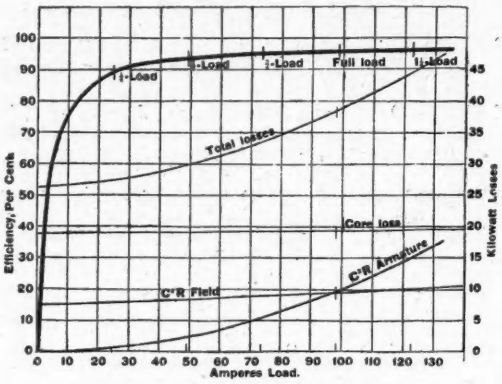
Paisley.—The Town Council has agreed that the price of electricity for lighting purposes be 6d. and 2d. per unit, in place of 7d. and 3d. as at present, and for power and heating 2½d. per unit. A member moved that the price of the light be not reduced, but withdrew his amendment on the understanding that the committee could consider the advisability of arranging a uniform rate in future.

(*Continued on page 976.*)

CENTRAL LONDON RAILWAY.

(*Continued from page* 929.)

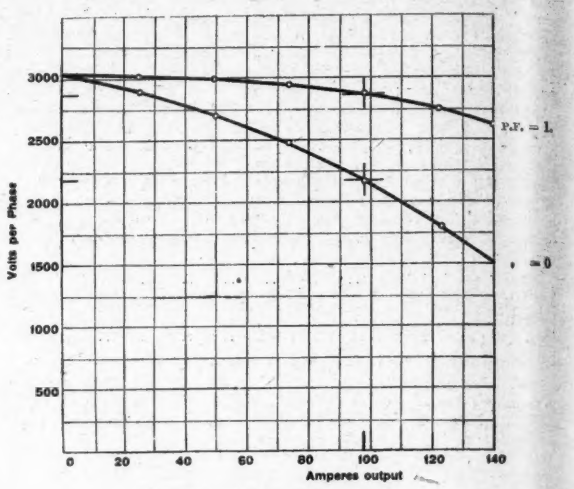
THE four cooling towers, which we illustrate, are of the Barnard-Wheeler type, consisting of galvanised iron wire netting suspended within an iron casing; they are built over a deep tank, and are 14 feet 8½ inches wide overall, and 50 feet in total height. The hot water is delivered to the top of the towers and trickles down the netting, while a blast of air is forced into the base of the tower by means of four double fans, and is deflected upwards by curved baffle plates. The fans are driven by separate Belliss single cylinder engines placed inside the main building; these are of 35 H.P. each, and run at 180 revolutions per minute.



EFFICIENCY CURVE OF ALTERNATOR.

The greater part of the heat contained in the water is carried off by the air current, and very little water is lost by evaporation.

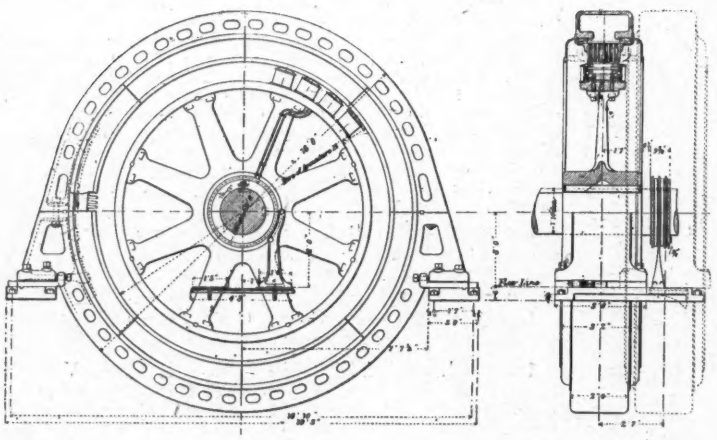
The main generators are of the three-phase alternating current type, with stationary armature and revolving field mounted direct on the crankshaft of the engine; each has an output of 850 KW. at 5,000 volts, 25 periods per second. The armature core is built up of sheet-iron laminations ·014 inch thick, secured by dovetails and clamps to a cast-iron frame. The length of the core parallel to the shaft is 14½ inches; deducting five ½ inch ventilating ducts and the space occupied by insulation between the laminæ, the net core length is 10·8 inches. There are 192 slots, each 3·625 inches deep by 1·313 inches wide. These are open at the core face, so as to admit of the coils being wound on formers and laid in place. A distributed winding is used, each coil occupying two entire slots, and there being two slots per phase per pole; by this means the inductance is reduced, and the heat losses are spread over a larger radiating area than if the winding were concentrated. Each coil consists of 14 turns of stranded conductor made up of 36 wires, No. 17 B.W.G.; the coils are wound on formers and carefully insulated, and are fixed in place by means of wooden ips held in dovetail grooves at the mouth of the slots. 1 om the drawings given herewith, it will be seen that the arma-



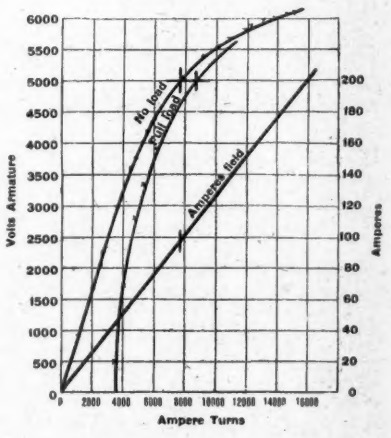
VOLT-AMPERE CURVE.

ture can be moved bodily sideways, clear of the magnet wheel, and as the coils are cranked at the ends in two layers, it is possible to remove any one of 48 without disturbing the rest; by the removal of the coils on each side of it, any one of the other 48 can be taken out. There are 32 coils per phase, connected in series, making 896 active conductors; the three phases are joined up on the star system, with the neutral point connected to earth.

The magnet wheel consists of a heavy cast-iron spider, carrying a cast-steel ring, to which are bolted 32 magnet cores. The pole-pieces, which are laminated, are 14½ inches wide, with a pole arc of 9 inches; the diameter over all is 143·375 inches, while that of the armature core inside is 144 inches, the air gap, therefore, being 0·3125 inch deep. The field magnet coils consist of 79½ turns of copper strip wound on edge, measuring 1·5 inches × 0·08 inch; they are wound on formers, slipped on the cores and held in place by wooden flanges. By adding the half turn, the terminals are brought to opposite sides of the wheel, so that, the adjacent terminals being joined together, a simple and efficient system of coupling is obtained. The exciting power at full load is 13·75 KW., with power factor unity; the induction density

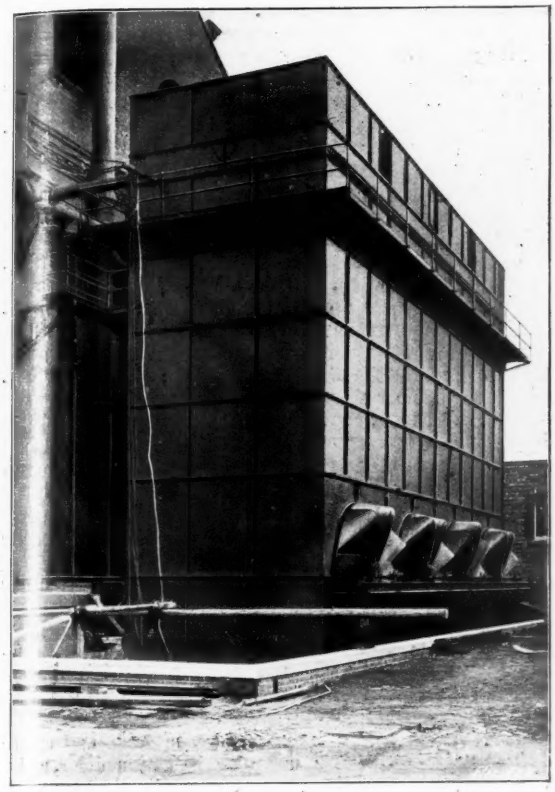


ELEVATION AND SECTION OF ALTERNATOR.



MAGNETISATION CURVE.

in the laminated poles is then 91,100 lines, in the yoke 54,700, and in the core 50,200 lines per square inch, while the current density in the field winding is 920, and in the



Cooling Tower.

armature conductors 1,040 amperes per square inch. The exciting current is conveyed to the field by means of two rings mounted on the main shaft, and provided with two copper gauze brushes each.

The magnet wheel, complete, weighs 34,000 lbs.; the armature iron weighs 4,500 lbs., and the complete armature 48,600 lbs. The armatures are tested after completion at a pressure of 10,000 volts alternating. We reproduce the magnetisation and efficiency curves of one of these alternators, as well as the volt-ampere curve with constant excitation. From these it will be seen that the commercial efficiency observed at full load is 95·5 per cent., and at 25 per cent. overload it is 96 per cent., tending upwards. On the same diagram as the efficiency curve are also shown the losses in the various parts of the machine.

The volt-ampere curves are given for a power factor of unity, and a power factor zero; for all other values of the power factor, the curves will, of course, lie between these two.

The magnetisation curve requires no explanation.

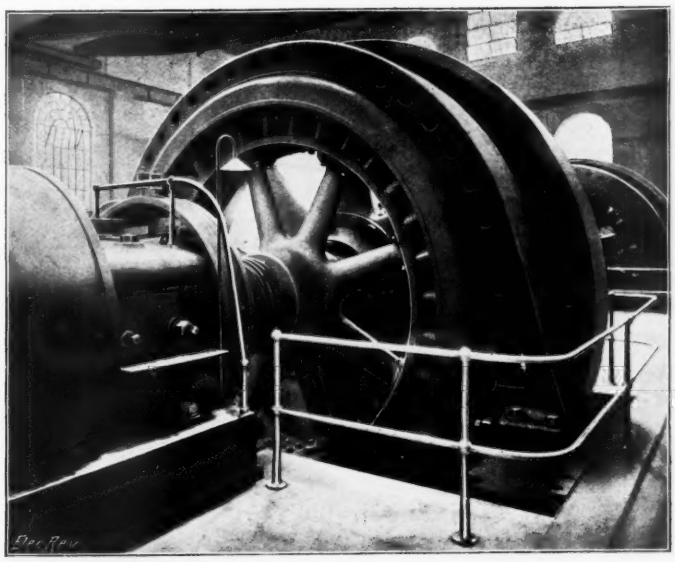
The exciters are four in number, with six-pole field magnets and drum armatures; each of these has a rated output of 50 KW. at 125 volts, and is driven direct at 400 revolutions per minute by a tandem compound Allis engine, with very interesting valve gear. These engines have cylinders 9½ and 15 inches diameter, with a stroke of 6 inches, and run quite silently; they are controlled by governors of the fly-wheel type. One of our illustrations shows them ranged along the north end of the engine room, while another view shows the two B.T.H. direct current 500—525-volt compound-wound generators which are used for lighting the works and yards. These, also, are six-polar, generating 50 KW. at 400 revolutions per minute; they are driven by Belliss two-crank compound engines of the single valve pattern, with forced lubrication and shaft governor. The exhaust steam from all the exciters and lighting machines is taken to the Wheeler surface condenser described in our last issue.

A vacant space near the lighting plant will shortly be occupied by a rotary converter, which will feed into the western end of the railway; there are at present no direct current railway generators in the main station.

As will be seen from our general view of the engine room, looking northwards, the switchboard is mounted upon a lofty gallery at the north end, overlooking the whole of the machinery. It consists of 12 double panels of white marble, bolted to angle-iron uprights. We give below a diagram showing the general arrangement of the electrical connections, omitting, however, three of the exciters and four of the generators.

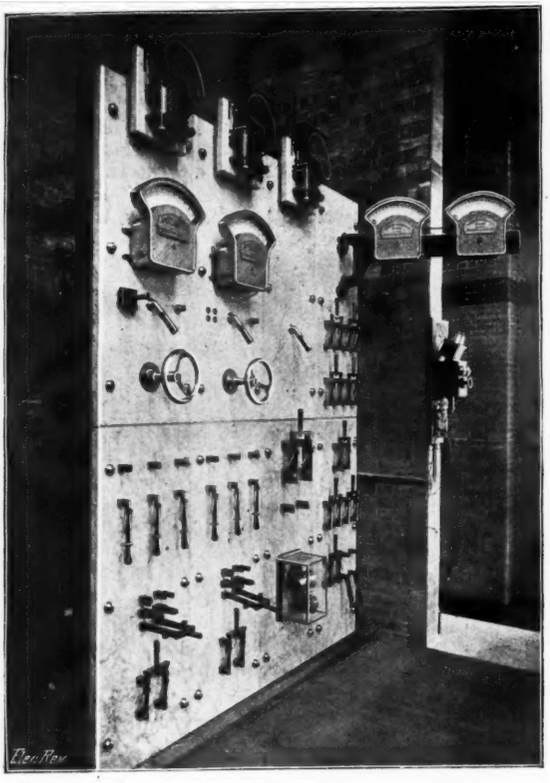
The four panels on the left are devoted to the exciters, and are fitted with Weston ammeters, field rheostats, and voltmeter plug switches on the upper part; double-pole 400-ampere switches, field switches, and minimum current cut-outs in the lower part. The field and main switches are interlocked, so that the former cannot be opened while the main is closed. The field switch is also provided with a very neat discharging device; the switch bar, in leaving the contact jaws connected with the exciter bus bars, passes through another pair of contacts, allowing the fields to run down through a non-inductive resistance; the latter contacts are formed of springy brass, cranked so as to clear the switch bar in its normal closed position. The interlocking arrangement is clearly shown in the drawing reproduced on another page, together with diagrams showing different stages of switching in or out; the device is extremely compact and unobtrusive. Two illuminated-dial Weston voltmeters are mounted on a swing bracket at the end of the board.

Next to the exciter panels come six large generator panels. At the top of each of these is a three-phase double-break aluminium-bladed switch, of the type invented by Mr. Parshall, and similar to those in use at Ringsend power station. The details of the construction of this switch are shown in the drawing which will be found on a later page. As will be seen, each switch has two blades, one on either side of the marble panel;



Three-Phase Alternator.

these are geared together by means of toothed sectors at their lower ends, and are electrically connected by flexible copper strips. The contact jaws are insulated with ambroin pillars, and are exposed on opposite sides of the panel;



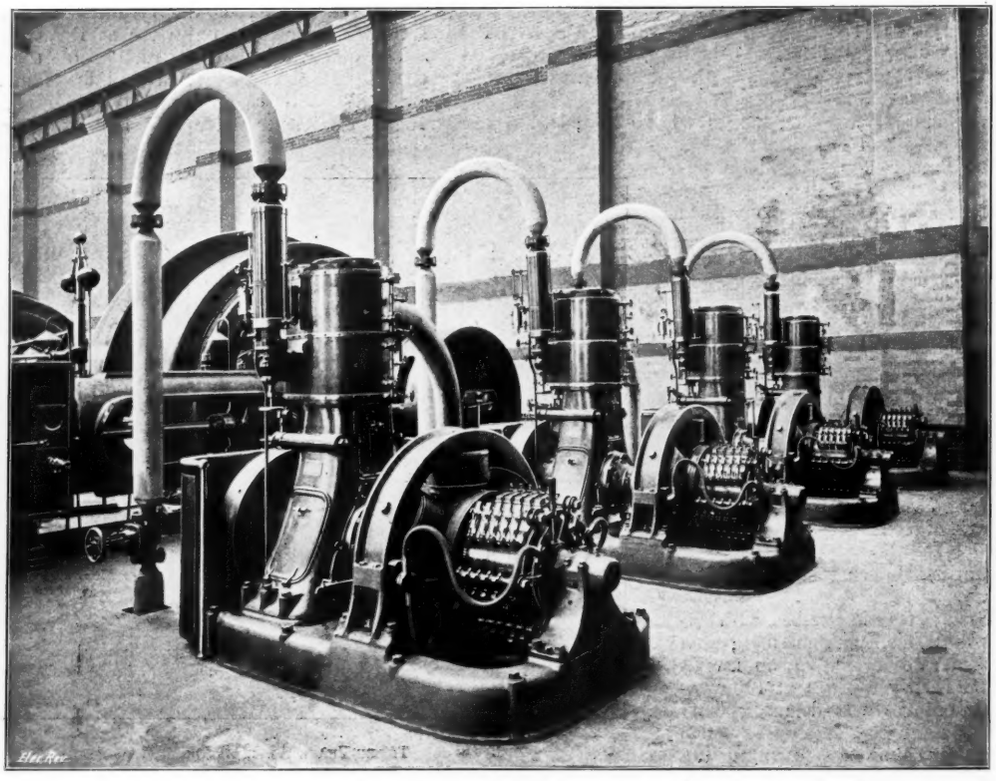
Lighting Switchboard.

the edges of the aperture in the marble are also well covered, and the gun-metal base insulated therefrom. The switch is operated by means of a heavy lever, with a wooden connecting rod behind the board; the rod is provided with a slotted link at the upper end, and a pair of springs, by means of which a quick-break is ensured. Adjustable air dashpots cushion the blow on opening the switch. The whole of the high pressure parts, both before and behind the board, are placed high up out of reach.

All the alternating current ampere and voltmeters are of the Hartmann & Braun hot wire pattern; there are four on each generator panel:—one voltmeter, coupled to the secondary of a small single-phase transformer, reducing the generator pressure in the ratio 40 : 1; two ammeters, connected in the secondaries of two bus-bar transformers, and indicating the currents in two of the phases; and one ammeter shunted by a low resistance in the direct current exciting circuit. There is also a voltmeter plug switch and a lamp switch on each panel.

The lower part of the generator panel carries the field rheostat regulating switch, and a double-pole field discharging switch, similar to those on the exciter panels; the field resistance is fixed against the wall beneath the switchboard gallery. Two large illuminated dial voltmeters are mounted on a swing bracket in the centre of the switchboard; the upper one indicates the bus bar pressure, while the lower is used for synchronising—a function which appears to be admirably fulfilled by these instruments, which are practically dead-beat, and quite quick enough in action for the purpose, although they are on the hot-wire principle. Two synchronising lamps are mounted over these voltmeters, and a red lamp on each panel is constantly alight when the corresponding generator is excited.

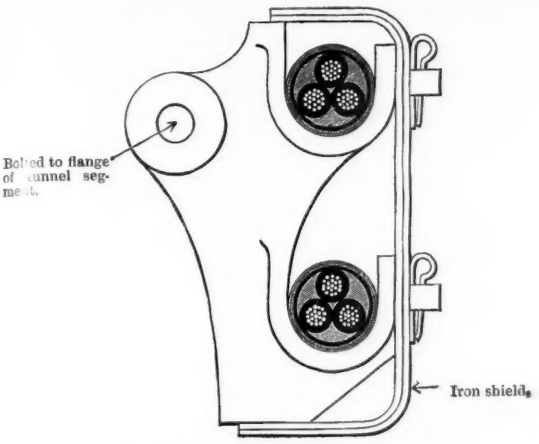
The two feeder panels carry three-phase switches similar to the generator switches, and a bus bar transformer ammeter in each phase, while the lower part of each panel is fitted with a Holden indicating wattmeter, and a Thomson integrating wattmeter. The Holden wattmeter is of special interest; it consists of an induction motor and a torsion dynamometer, the latter acting as a relay to control the former. When a load comes on, the movable coil of the dynamometer closes the circuit to the induction motor, which begins to move the pointer, and at the same time to extend a spring; the latter is connected with the moving dynamometer coil, and when its tension equals the electro-



Exciting Sets.

dynamic force acting on the coil, the relay circuit is broken and the motor stops. The scale, which is uniform, extends over 300°.

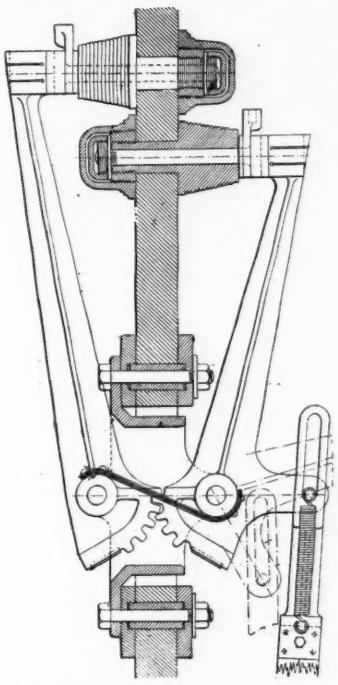
There are four outgoing feeders, only two of which are provided for on the main switchboard itself; the other two are to be controlled by oil-break switches fixed beneath the gallery. We give views showing the construction of these



High Tension Cables and Support.

switches, from which it will be seen that they consist simply of three double-break switches immersed in oil in a strong steel cylinder. The simplicity and compactness of this type of switch are strong points in its favour, while its substantial construction renders breakdown highly improbable.

At the right hand end of the gallery is a four-panel lighting board, equipped with automatic circuit-breakers, controlling the generators and the various lighting circuits. Between this and the main board is a space which is about to



Parshall High Tension Switch.

be filled by a panel devoted to the power station rotary converter; the other panels connected with the converter

Engine Room, looking towards Switchboard.

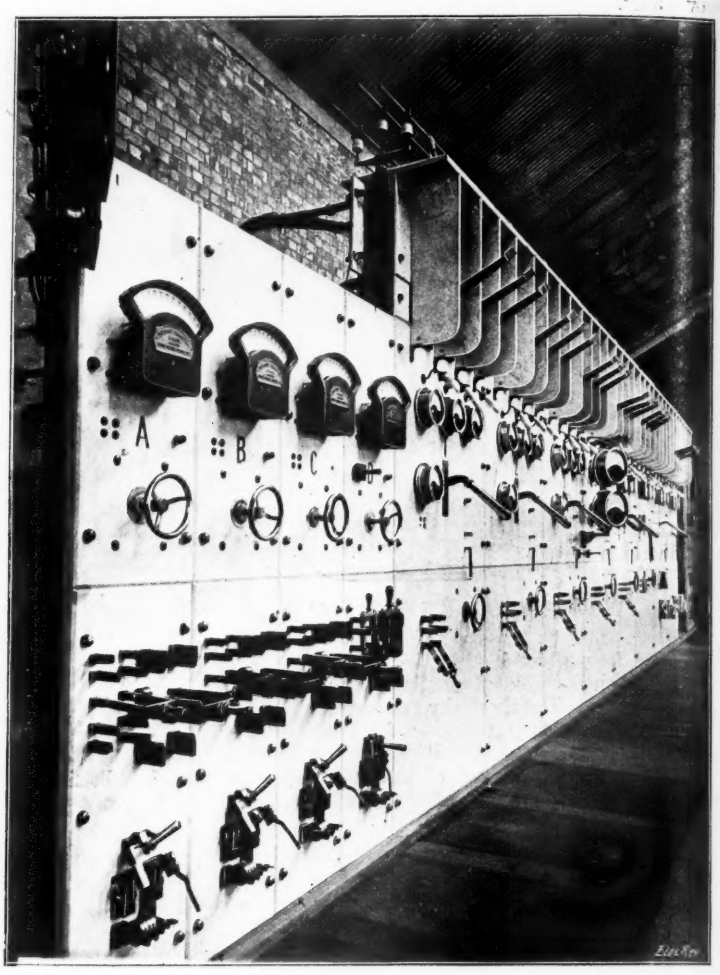
Weston ammeters and swing-bracket voltmeters, shunt rheostat hand-wheels and field switches, as well as switches will be mounted on a lower gallery on the east wall of the engine room, close to the machine.

The switchboards form part of the contract of the British Thomson-Houston Company, who undertook the supply and erection of the whole of the generating, distributing and propelling plant. The instruments and switch gear have a uniform copper finish, which, with the white marble and ebony handles, makes a strikingly handsome combination. As none of the high pressure parts are accessible from the floor level of the gallery, whether before or behind the board, there is no more danger to the attendants than on an ordinary low tension board, while ample space is provided behind the board, which stands over 5 feet away from the back wall. A telephone outfit close to the lighting board affords ready communication with all parts of the station and car sheds, and with the various sub-stations, and another telephone station in an office near the gallery provides a connection with the National Telephone Company's system.

The remaining electrical apparatus to be installed at the generating station consists of a 900-KW. rotary converter, four single-phase 300-KW. transformers, and a blower set; these are practically identical with the equipment of the sub-stations, one of which —the Notting Hill Gate station—we shall presently proceed to describe.

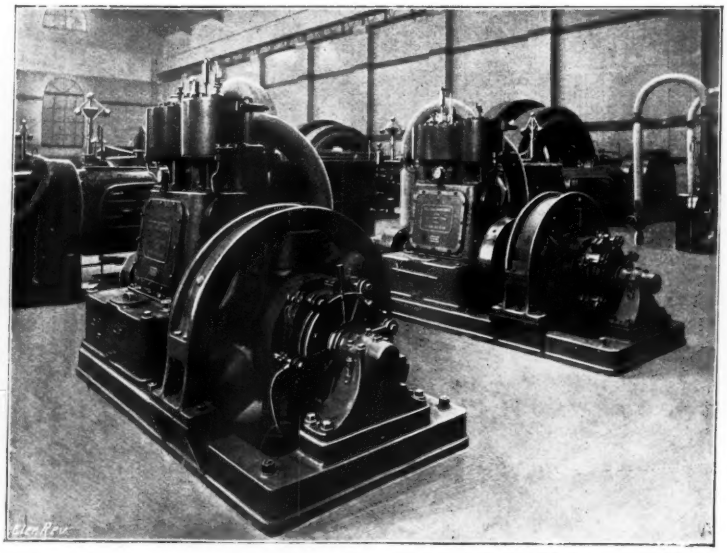
The general plan adopted for the power transmission is briefly as follows:—The high tension current generated at the power station is transmitted at 5,000 volts to three sub-stations, situated in the base of the lift shafts at Notting Hill Gate, Marble Arch, and the Post Office passenger stations respectively, in addition to the converter installation in the power house itself. At each sub-station the 5,000-volt supply is transformed down to 305 volts and fed to the slip rings of the rotary converters, which supply direct current at 500 volts to the sub-station bus bars. From these, feeders are taken direct to the "third rail" and to the running rails near the sub-station.

Before deciding on this system, several other methods of supply were carefully inquired into.



MAIN SWITCHBOARD.

The direct current system, feeding from Shepherd's Bush direct to the line, was far too costly in copper. The adoption of the three-wire system would have greatly reduced this item; but it must be remembered that with the stations at such short intervals, a train is either taking a heavy current (not far off 1,000 amperes) during acceleration, or is entirely cut off while approaching a stopping-place, there being practically *no* period of running at constant speed. With over 20 trains making these sudden and variable demands, the balancing of a three-wire system would have presented almost insuperable difficulties, and the outlay on copper would still have been excessive.



LIGHTING SETS.

The direct application of polyphase motors on the locomotives, with high tension transmission and transformers in sub-stations, was quite feasible but by no means economical, for the induction motor is at its worst when getting up speed—which, as shown above, is practically the whole duty of the motors on this line. Direct current motors, with series parallel control, are at present unexcelled by any other type of motor under these conditions.

There remained, therefore, only two systems to choose from: motor-generators, and rotary converters with stationary transformers; the primary supply in either case being high pressure alternating, and the secondary supply direct current at 500 volts. The former was found to be the more costly and the less efficient system, although it had the merits of simplicity and better regulation. Finally, therefore, by this process of elimination, the rotary converter system was found to be the most suitable. Further, as the whole of the primary supply was intended for power purposes, all lights being supplied on the direct current system, and as the cables were of necessity run

underground, with continuous insulation, there could be no possible doubt as to the superiority of the three-phase system with the middle point earthed.

Passing on to the transmission line, we give a view showing

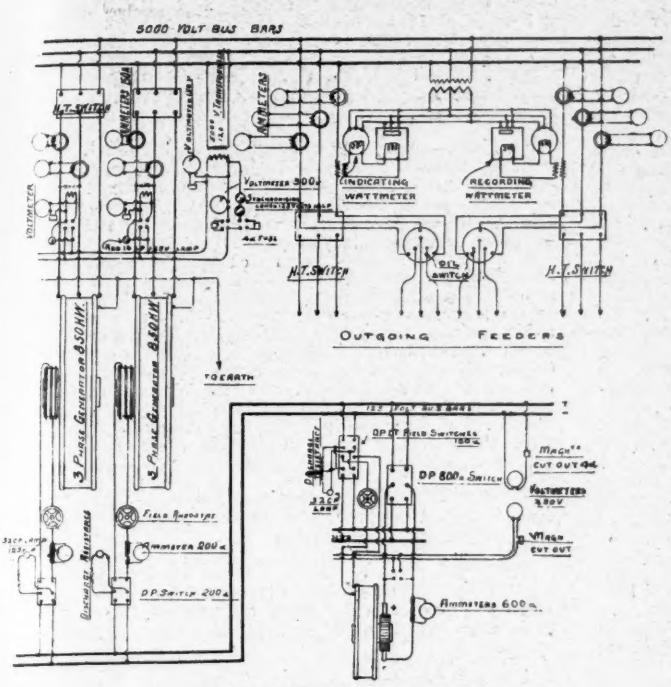
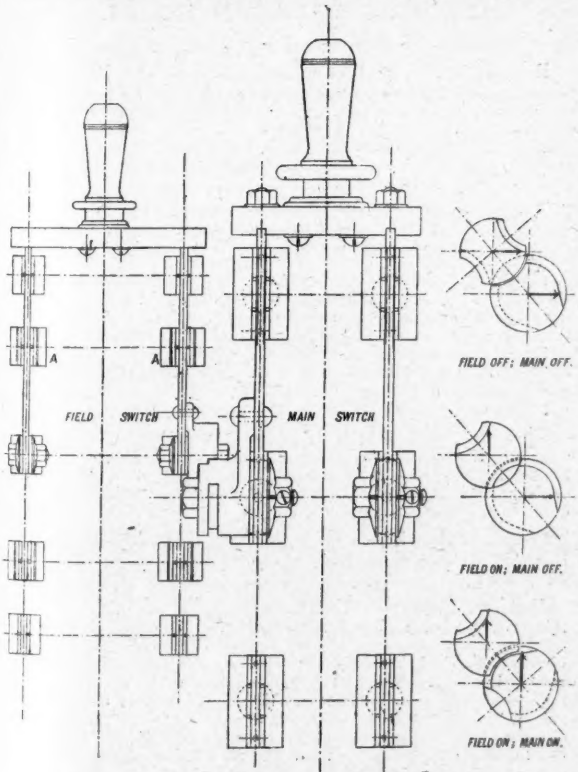


DIAGRAM OF CONNECTIONS.

a cross-section of the cables, together with one of the cast-iron supports upon which they are laid in the tunnels. The cables are paper insulated and lead-covered, with three cores,



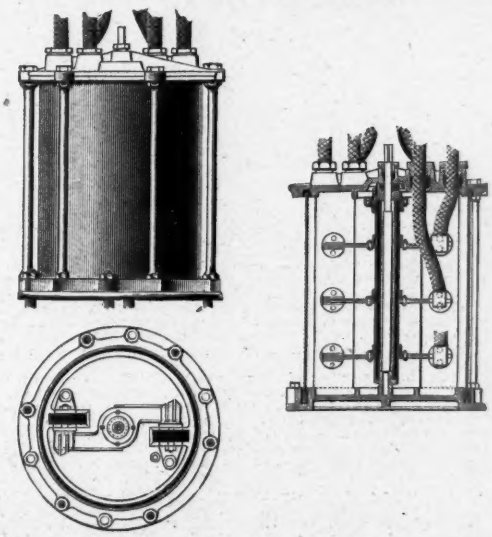
EXCITER SWITCHES, SHOWING INTERLOCKING DEVICE.
A A, Contacts of field-discharging resistance.

and were made by the National Conduit and Cable Company. They were tested with 15,000 volts alternating after completion, and with 10,000 volts for one hour after laying, applied between the various cores and between the cores and earth. There are four independent cables, each having a total copper cross-section of 0·1875 square inch between the power station and Notting Hill Gate, and 0·125 square inch from the latter to Marble Arch; here two of the cables end, the other two going on to the Post Office sub-station, where the high tension line terminates. Two of the cables are carried along each tunnel on the supports illustrated, which are bolted to the flanges of the cast-iron lining of the tunnel; they are protected from mechanical injury by means of curved sheet-iron plates throughout their length.

At Notting Hill Gate the cables are led to a connection box, one in each tunnel, in a small brick chamber; the cables terminate on a marble connection board, which also bears the terminals of the corresponding feeders going to Marble Arch, and a cable running into the Notting Hill Gate sub-station. By means of this board any cable may be totally cut off from the system, or the sub-station itself may be isolated. Similar boards are installed at the Marble Arch sub-station.

The insulation of the separate cores consists of paper impregnated with resinous oil, $\frac{1}{8}$ inch thick, with an outer covering of paper of the same thickness. The larger cables have 37 strands per core, and measure $2\frac{1}{8}$ inches diameter overall; the smaller cores are 19 strand each, with a finished diameter of $1\frac{5}{16}$ inches. The total length of high tension cable employed amounts to 19·6 miles, weighing 78·4 tons.

When testing the insulation resistances some interesting data were obtained regarding the capacity of the cables. With a pressure of 10,000 volts, at 25 periods per second, applied to two cables in parallel (one core from each connected together and tested against the other four cores and sheathing) the capacity current was found to be 1·9 amperes from the power station to Notting Hill Gate, 3·7 amperes to Marble



HIGH TENSION OIL-BREAK SWITCH.

Arch, and 4·7 amperes to Post Office. From these and other figures the following values have been computed :—

Capacity per mile between one core and—

(*a*) Other two cores and sheath	... ...	0·38 mfd.
(*b*) Other two cores	... ...	0·32 "
(*c*) One other core	... ...	0·23 "

(To be continued.)

Amendment of Patent.—Mr. W. J. Still, of Toronto, has applied for leave to amend Patent No. 21,835 of 1898 for "improvements in storage batteries." For particulars see our advertisement pages.

ELECTRIC LIGHT AND POWER NOTES.

(*Continued from page* 969.)

London.—MARYLEBONE.—Mr. Boulnois, M.P. for East Marylebone, has informed the Vestry that while he is willing to oppose the confirmation Bill of the Marylebone Electric Supply Company, if desired by the Vestry, he does not approve of the Vestry obtaining powers to compete with the present company.

SHOREDITCH.—The clerk submitted to the vestry at the meeting on Tuesday, a letter from the Marylebone Vestry drawing attention to the attempts made in the past by that authority to obtain electric lighting powers, and stating that a further application was intended to be made for a provisional order. In that connection the letter mentioned that if the Bill introduced to confirm the order granted to the Marylebone Electric Supply Company was passed, it would seriously endanger the vestry's scheme, and in view of the importance to London local authorities of the principle involved, the vestry asked the Shoreditch authority to take steps to oppose the passing of the confirmatory Bill. On the motion of Mr. Wells, however, it was decided to take no action in relation to the matter. The Public Health Committee reported that in consequence of black smoke nuisance at the vestry's generating station in Coronet Street, they had caused a notice to be served upon the vestry requiring the abatement of the evil within seven days. Mr. Clark said that if the committee had not taken action, the County Council would have done so, but he was happy to say that the nuisance was abated within the stipulated period. Mr. N. Moss, chairman of the Lighting Committee, stated that the trouble was not likely to occur again. The engineer had reported that on the particular occasion in question, the issue of black smoke was due to the destruction of some very peculiar trade refuse which had been sent to the works, and he had undertaken not to accept any such stuff in the future. It was decided to approve the action of the committee. In connection with this subject, the vestry accepted tenders for the supply of Welsh coal at prices ranging from 27s. 6d. to 30s. 9d. per ton up to March 31st, 1901. The Lighting Committee reported having considered the great delay on the part of the London County Council in the granting of the loan required to complete the Hoxton station. On the recommendation of the committee it was resolved to place the facts of the case before the County Councillors representing the district, with a view to remedying the matter.

LONDON, E.C.—The City of London Electric Lighting Company, Limited, is circularising its consumers as follows:—

VISION OF THE RATES OF CHARGE FOR ELECTRICITY FOR LIGHTING, &c.

In pursuance of the notice which was given by public advertisement in the newspapers in March last, a copy of which is appended hereto, I am directed to inform you that my board have resolved to apportion the 12 units, to be charged at 8d. per unit, referred to therein in the following manner.—

Two units in the June quarter.			
Two	"	"	Sept. "
Four	"	"	Dec. "
Four	"	"	March "

J. CECIL BULL,
Manager and Secretary.

May, 1900.

COPY OF ADVERTISEMENT.

Notice is hereby given, that as from the dates when the meter readings for the March quarter were taken and until further notice by public advertisements, the following revised rates will be charged by the company for electric energy, whether supplied on the alternating system or the continuous current system, for all purposes except for driving motors:—

The rate for motors will remain as hitherto at 2½d. per unit.

The revised rates will enable those consumers who use their lamps continuously for long periods to obtain current at a greatly reduced cost per unit, and at rates which are much lower than the price of gas.

Every customer will be charged for the current which he may consume up to 12 units per annum per 8-C.P. lamp fixed (or its equivalent) at the rate of 8d. per Board of Trade unit. All current consumed in excess of the above-mentioned 12 units per 8-C.P. lamp will be charged at the very low rate of 2d. per B.O.T. unit.

The effect of this system of charge will be that those consumers who use their lamps for long hours will greatly benefit, according to the periods for which they employ their lamps, whereas those customers who use their lamps very occasionally, and then only for short periods, will have to pay a more equitable proportion of the cost of supplying them. Twelve units per annum are approximately equal to one hour's average daily use of an 8-C.P. lamp.

In cases of mixed installations of many long-hour and few short-hour lamps, suitable arrangements will be made upon application, so that such consumers may derive the full benefit of the scale in respect of their long-hour lamps.

Melton Mowbray.—Electricity *v.* gas was the subject of a discussion at last week's Council meeting. Gas won, and the district is to be lighted by the gas company at £383 for one year.

Middlesex.—The Middlesex County Council is opposing the Bill confirming the electric lighting orders for Twickenham and Uxbridge.

Perth.—The electricity works are being pushed on with. The committee is inquiring into the refuse destructor plants in other towns.

Seaham Harbour.—The Lighting Committee, and the would-be electric lighting undertakers, could not agree as to a purchase clause in the terms of arrangement. Modifications were made to meet the company, but the Board of Trade has decided not to proceed with the company's application. The Committee will now consider the advisability of carrying out a scheme themselves.

Simla.—Electricity is making way in the summer capital of the Government of India. Four schemes have been proposed for the lighting of Simla by electricity, says the *Globe* correspondent, and Mr. Meares, electrician to the Bengal Government, is expected there shortly to report upon the more promising of them. All four propose to employ water-power and turbines for generating the necessary current. The principal question is as to which of the numerous hill streams in the neighbourhood of Simla offers the best prospect of efficient and economical working, and the matter resolves itself into a question solely of cost.

Sleaford.—The Urban Council's provisional order passed the Standing Orders' Committee last week, and was sent to the House of Lords for second reading.

Stafford.—The annual report of the Gas and Electricity Committee shows that an increased cost of coal will have to be faced this year by the gas department, amounting to something like £3,000, but it is not proposed to raise the price of gas. With regard to the electricity department, the report shows an increase of 19,593 units in the current generated during the year, or 20 per cent. more than last year. The equivalent in the number of 8 C.P. lamps connected was 8 558, being an increase of 1,212. The total revenue amounted to £1,772, an increase of £329, and the gross profit was £789, but there was a debit balance upon the year's working of £375. This compared very favourably, however, with the previous year, when the debit balance was £514. In order to further popularise the use of electricity, the Committee had now reduced the price to a uniform charge of 5d. per unit, and abolished meter rents. Alderman Wright announced with regret that the Council were about to lose the services of Mr. Bell, the gas and electricity engineer, who had been appointed manager to the Derby Gas Light and Coke Company, at a much larger salary than he was now receiving.

Todmorden.—The Town Council has disapproved of a proposal of the Yorkshire Electric Power Company to supply electricity in bulk to the Council.

Tottenham.—The District Council has resolved to join the Edmonton and other Councils in promoting a Bill in Parliament, with a view to carrying out a joint electricity supply undertaking in opposition to the North Metropolitan Electric Supply Company's scheme.

Wood Green.—The District Council is inquiring into the electric lighting question.

ELECTRIC TRACTION NOTES.

Blackburn.—The first annual report of the Blackburn tramways since they were municipalised shows a net loss of £4,500, notwithstanding an increase in the number of passengers and the substitution of electric for steam traction on one half of the system. The deficiency is due to reduction of fares, increase of the men's wages, the rise in coal, and the cost of repairs. The Darwen steam section shows a substantial profit.

Bristol.—The city engineer has reported that the tramway company has modified its scheme for the Hanham light railway, and the plans have been approved.

Burnley.—The Town Council has decided to proceed with the reconstruction and electrical equipment of the tramways within the borough as soon as practicable after their acquisition by the Corporation from the tramway company next August. It is estimated that the cost of reconstructing the line from Padiham through Burnley and Brierfield to Nelson, a distance of seven miles, will be about £100,000, apart from the cost of the existing line and rolling stock.

The City and South London Railway.—The extension from Stockwell to Clapham Common of the City and South London Railway was opened on Sunday for public traffic, a down train starting from Moorgate Street and an up train from Clapham Common simultaneously at noon.

Cradley Heath.—It is stated that the Cradley Heath Electric Tramway is likely to be completed and opened in about six weeks' time.

Durban and Salisbury.—The *British and South African Export Gazette* says that the first contract of the electric tramway for the provision and laying of 15 miles of steel rails has been awarded to the well-known Johannesburg firm of Messrs. Hubert Davies & Spain, their tender amounting to £30,286. The tenders for the second contract have just been invited. It is divided into three sections—the first being concerned with the supply and erection of the overhead installation; the second with the furnishing of 22 double-deck motor cars; and the third the supply and erection of a complete steam and electric generating plant, including three 250-KW. direct-coupled generators, boilers, condensers, cooling tower, switchboard, &c. It is thought that the completion of the whole scheme, up to delivery for working, will take upwards of two years. In the meanwhile, the overworking of the tramcar horses, due to the increased traffic, has called forth the suggestion that the Town Council should acquire a second-hand steam, petroleum, or electric accumulator motor car from Home contractors, as auxiliary to or to replace the horse traction.

The Town Council of Salisbury, Rhodesia, is deliberating on the feasibility of carrying out an omnibus scheme for providing the town with electric light and traction, and a water service.

Germany.—During the course of the present year seven new lines of electric tramways are to be constructed in the town of Stuttgart.

The Jungfrau Railway.—The *Times* says that the section of the Jungfrau Railway between Kl. Scheidegg and Eigergletscher was reopened for traffic on Sunday, but owing to the condition of the snow, the farther section between Eigergletscher and Rothstockschlucht will not be available until later on.

Kinver.—The cause of the delay in the completion of the tramway line, which has been due to a dispute between the British Electric Traction Company, and the Staffordshire County Council, is now happily disappearing. The main point at issue was as to the track to be followed on the road between the Ridge, Wollaston, and the Stewpony. An appeal was made to the Board of Trade, and as a consequence, Col. Yorke visited the district last week and met representatives of the Staffordshire County Council and of the company, and also of Mr. P. H. Foley, owner of the land. Col. Yorke has specified what must be done, and there is no doubt the work will now be pushed on. It is hoped that the line will be completed in two months' time.

Leeds.—On Monday a girl eight years of age was run over and killed by an electric car.

Russia.—The necessary permission has just been obtained to convert the horse tramways in the town of Tiflis to electric traction.

Southampton.—The second section of the electric tramways was opened for traffic on Tuesday last week, it having been previously inspected and passed by Mr. Trotter and Col. Yorke, on behalf of the Board of Trade. The members of the Tramways Committee and the officials went for a run on the line, and afterwards lunched together.

TELEGRAPH AND TELEPHONE NOTES.

The Balmoral Telegraph Staff—The Queen has personally handed a gold scarf pin, bearing her initials, "V.R.I.," to Mr. R. Anderson, chief of the Balmoral telegraph staff: and also walking sticks, beautifully mounted, to three other members of the staff, for the satisfactory way in which they have accomplished the heavy work connected with the birthday congratulations.

Dover Telephones.—At the last Council meeting, when Mr. A. R. Bennett's report on a municipal telephone system came up for consideration, Alderman Pepper moved that the consideration of the report of this matter should be again adjourned. The question of municipal telephones was a grave one. He had altered his mind about it. It was a question whether they would gain by having municipal telephones, even against the National Telephone Company, which was not any too courteous in demeanour. Councillor Lewis seconded the adjournment. Councillor Chitty said the report was certainly very full, and showed some reasons why a municipal exchange might be very beneficial, but he saw no objection to adjourning the discussion. Councillor G. Mowll said one reason why it should be adjourned was because he did not think any of the Council knew what was being paid to the company for the wires now in use, and this sum should be put to the credit of the proposed exchange. All the different fire stations, &c., had not yet been connected with the telephone, and there was also the question of whether they could not introduce telephonic fire alarms and other facilities. He was rather disappointed with the report. All the matters he had mentioned should have been put to the credit of the account. The question wanted very carefully looking into. The consideration of the report was again adjourned.

King's Norton Telephones.—The King's Norton District Council is placing both its cemeteries in communication with the telephone exchange. Is this for the discomfiture of departed spirits? We have sometimes thanked our lucky stars that the telephone exchange was confined to this life. Henceforth we shall prefer Woking to King's Norton.

Leicester Telephones.—The town clerk is making a canvas to ascertain the amount of support that would be accorded to a municipal telephone exchange, if the following terms are charged:—

£6 6s. per annum, payable in advance, to cover an unlimited number of calls; or alternatively, £3 10s. per annum, payable in advance, and 1d. for each call (originated by the subscriber) payable every three months. The subscriber may be called up by other subscribers without any charge.

The above rates are for service up to a mile from the exchange, and for any excess distance beyond a mile there may be a small extra charge.

Agreements for one year.—Equally advantageous rates for partnership lines for unlimited user, or on the "toll system"; also for second instruments and extensions, will be quoted on application to the canvassers. Corporation subscribers will have, on payment of the usual trunk wire charges of the Postmaster-General, equal rights with the subscribers of any other telephone undertaking to the use of the Government trunk lines to other towns.

Manchester Telephones.—Mr. W. H. Vaudrey, the Deputy Lord Mayor, has been elected chairman of the Telephones Committee of the Manchester City Council in the room of Mr. Alderman Southern, who recently resigned the Chairmanship. The Committee resolved to ask by letter for a reply from the National Telephone Company to the inquiry by the Committee upon what terms the company are prepared to make over their business in the city to the Corporation.

Telegrams to South Africa.—The Eastern Telegraph Company, Limited, announced early in the week that, owing to a large amount of traffic and to a temporary interruption of the cable between Durban and Delagoa Bay, ordinary and press traffic to South Africa is subject to delay. The interruption of the Durban cable is only about 11 miles from that place. The cables between St. Thomé and Loanda (on the West Coast of Africa) are interrupted.

The Eastern Telegraph Company were informed on Wednesday morning by Delagoa Bay that communication by landline between that place and Pretoria is interrupted. The line from Delagoa Bay to the Transvaal is, however, open as far as Middelburg.

Telegraphic Interruptions and Repairs:—

Cables.	Down.	Repaired.
West Indies:—		
Jamaica-Colon	June 30, 1899 ...	...
Trinidad-Demerara (1871)	Working badly. May 11, 1900.	
Mole St. Nicholas-Cape Haitien ...	March 6, 1900 ...	...
Cayenne-Pinheiro	Oct. 11, 1899 ...	...
Cayenne-Paramaribo	Feb. 16, 1900 ...	...
Ceará-Maranham	Feb. 20, 1900 ...	...
Pará-Maranham	March 1, 1900 ...	...
Latakia-Cyprus	June 20, 1899 ...	...
St. Thomé-Loanda	May 19, 1900 ...	...
Tarifa-Tangier	Jan. 2, 1900 ...	...
Landlines.		
South African:—		
Communication with Mafeking and beyond	Oct. 13, 1899 ...	...
Communication beyond Newcastle	Nov. 7, 1899 ...	...
Communication with all offices beyond Kimberley	Oct. 18, 1899 ...	...
Communication with all offices of Colombia beyond Buenaventura...	Feb. 22, 1900 ...	...
Communication "*vid* Hanekine" interrupted on Persian Territory	Feb. 24, 1900 ...	...
Ecuador landlines	Mch. 13, 1897 ...	...
Brasilian landlines, south of Macahé	Apl. 25, 1900 ...	...
Saigon-Bangkok	June 4, 1900 ...	June 4, 1900.

Tokio Telephone Service.—A financial paper says that Tokio has no less than 5,645 telephone subscribers, and the demand for new connections is increasing. At the present moment, when a telephonic connection lapses, it is often bought for 400 or even 500 yen. It is intended to extend the Tokio telephonic system in the course of this year and augment the number of existing apparatus by 1,700.

Wireless Telegraphy.—The decision of the Trinity House authorities to remove the wireless telegraphy installation between the South Goodwin lightship and the South Foreland was discussed by the Dover Chamber of Commerce on Friday. It was decided, says the *Times*, to memorialise the Trinity Board, and to request the Chamber of Commerce of the ports of the United Kingdom to support the memorial, as well as Lloyd's and other shipping bodies, with a view to the establishment of a connection between lightships and the shore on dangerous sands. It was urged that the number of lives and the quantity of valuable property which could have been saved from the Goodwins in recent years, had there been such communication with the shore, would have been enormous. The importance of fitting lightships with wireless telegraphy installations so that they could act as sentinels or scouts in time of war, and as a centre for the conveyance of important commercial telegrams from vessels to the shore, was also put forward as of national importance. The Chamber had written to the Trinity House pointing out the value the installation had been in reporting wrecks, and especially in the case where the lightship itself was collided with by the steamer *R. F. Matthews*, and badly damaged, narrowly escaping disaster. The Trinity authorities replied that the installation was experimental, and was removed at its conclusion, the subject being now under the consideration of a Departmental Committee. The Chamber considered that this installation, rather than being removed from sands so dangerous as the Goodwins, should have been retained while the Committee were considering the matter.

CONTRACTS OPEN AND CLOSED.

OPEN.

Bermondsey.—June 18th. The Vestry is inviting tenders for insulated electric mains, conduits, junction boxes, &c. See "Official Notices" June 1st.

Bootle.—June 16th. The Corporation wants tenders for underground electric cables, the erection of arc lamps, and the supply of mechanical stokers, for electric lighting. See "Official Notices" May 25th.

Blackpool.—June 18th. The Corporation wants tenders for the electrical equipment of 15 single truck tramcars. See "Official Notices" June 1st.

Bradford.—June 14th. The Corporation wants tenders for a switchboard for 500 volts pressure, or for alterations to the existing switchboard at the Valley Road electricity works. See "Official Notices" May 25th.

Brussels.—September 19th. The Council of St. Jilles, lez Bruxelles, invites tenders for the installation and the commencement of supply upon a part of its territory. Conditions and plan for three francs at the office, No. 14, Parvis St. Jilles, St. Jilles.

Bury.—June 18th. The Art Gallery Committee want tenders for the electric wiring of the Art Gallery and Free Library. See "Official Notices" to-day.

Crewe.—June 11th. Tenders are wanted by the Corporation for the wiring of the municipal offices, market hall, and corn exchange, and for supplying lamps and fittings for electrically lighting (separate quotations for arc and incandescent lighting) the same. Tenders to Town Clerk.

Croydon.—June 14th. The Council is inviting tenders for engine foundations and joists for flooring at the Corporation electric light station. Forms of tender, specifications, &c., from the Borough Electrical Engineer, Factory Lane. Deposit, 1 guinea.

Dudley.—June 15th. The Corporation is inviting tenders for a free wiring contract. See "Official Notices" June 1st.

Durban.—June 29th. The Corporation wants tenders for overhead equipment for (*a*) about 16 miles of single track, including poles, overhead trolley wire, distribution boxes; (*b*) 22 double-deck motor cars; (*c*) steam and electric generating plant, including three 250-KW. generators, boilers, condensers, cooling towers, switchboard, &c. See "Official Notices" May 18th.

Ealing.—June 11th. The District Council wants tenders for storage batteries and a steam dynamo alternator for the electricity works. See "Official Notices" May 25th.

Egypt.—July 1st. Tenders are being invited until July 1st by the harbour and lighthouse authorities at Alexandria for the supply and erection of the necessary plant and apparatus required for the electric lighting of the harbour of Port Said. Tenders are to be sent to L'Administration des Ports et Phares, Alexandria, whence particulars may be obtained.

France.—June 19th. The French Post and Telegraph authorities in Paris are inviting tenders until the 19th inst. for the supply of 300 tons of copper wire. Particulars may be obtained from, and tenders are to be sent to, Le Sous-Secretariat d'Etat des Postes et des Telegraphes, Rue de Grenelle 603, Paris.

Glasgow.—June 11th. The Corporation invites tenders for the excavator work required in the construction of Section No. 2 (North) of the new generating station at Port Dundas.

Glasgow.—June 12th. The Corporation wants tenders for the supply of two sets of switchboards and instruments for 4,000 amperes each, for the electricity department. See "Official Notices" May 11th.

Hackney.—June 13th. The Electric Lighting Committee is inviting tenders for the erection of buildings, foundations and chimney shaft for the Vestry electricity works.

Halifax.—The Corporation wants tenders for bar copper for electrical purposes, as well as for boilers and piping. See "Official Notices" June 1st.

Italy.—July 14th. The Municipal authorities of Maddalena (Sardegna), are inviting projects and tenders until July 14th, for the electric lighting of the public streets of the town. Particulars may be obtained from, and schemes and tenders are to be sent to, Il Municipio di Maddalena (Sardegna.)

Larne.—June 18th. The Urban District Council invite tenders for the lighting of their district by coal or acetylene gas or electricity, for three years, from August 1st next. Particulars from Mr. W. G. Younge, Clerk of the Council.

London County Council.—June 16th. The Council invites tenders for an electric lighting and power installation (excluding generating plant) telephones, fire alarms, &c., at the Horton Asylum, near Epsom. See "Official Notices" May 18th.

Manchester.—June 9th. The Tramways Committee wants tenders for the overhead equipment of three routes of tramways. See "Official Notices" May 25th.

Nelson.—June 12th. The Corporation invites tenders for a storage battery and switchboard. See "Official Notices" June 1st.

Newington.—June 15th. The Electric Lighting Committee requires tenders for supplying and laying conduits, mains, &c. See "Official Notices" June 1st.

Partick.—June 8th. The Commissioners want tenders for a dust destructor with furnaces, flues, water-tube boilers, economiser, fans, and forced draught appliances. See "Official Notices" May 18th.

Spain.—July 7th. The Secretary of State for Foreign Affairs has received a despatch from Her Majesty's Ambassador at Madrid, stating that tenders are invited by the Spanish Government, to be received not later than July 7th next, for the concession for an electric tramway from the Puerta de Hierro (Madrid) to Aravaco and Pozuelo. Some particulars may be examined on personal application at the Commercial Department of the Foreign Office between 11 a.m. and 5 p.m.

Stockport.—June 13th. The Gas and Electricity Committee of the Town Council wants tenders for two water-tube boilers. See "Official Notices" June 1st.

Sleaford.—June 12th. Tenders for multitubular boilers, two steam dynamos and booster, pumps, waterheater, pipework, accumulators, arc lamps, posts and connections, switchboard, cables, and grounding are wanted by the Urban District Council. See "Official Notices" May 25th.

Sutton Coldfield.—June 21st. The Corporation invites tenders for water-tube boilers and other steam plant, pipework, three steam dynamos and boosters; batteries, switchboard, overhead traveller, mains and conduits, arc lamps and posts, and station lighting. See "Official Notices" May 18th.

CLOSED.

Devonport.—The *Contract Journal* says that the following tenders were submitted to the Corporation for the supply and laying of electric light and traction feeders, distributors, boxes, &c., in connection with the electricity supply within the borough of Devonport and the district of the East Stonehouse Council. Mr. Charles Furness, borough electrical engineer:—

Callender's Cable and Construction Company*	£12,448 6 10
St. Helens Cable Company, Warrington	12,379 1 5
Henleys, London	12,555 6 4
Siemens, London	12,690 3 5
British Insulated Wire Company	12,875 16 0
Glover's	12,963 0 0
Western Electric Company	14,149 18 8

*Recommended for acceptance.

Dundee.—Messrs. Lowdon Bros. have secured the contract for an electric traction switchboard, &c., at the electricity works at £1,063. The British Insulated Wire Company are to supply cables and mains at £8,523, and Callender's Company for cables at £2,415.

Keighley.—The Electricity Committee recommend the acceptance of the following tenders:—Messrs. Clayton, Son & Co., Limited, for Lancashire boilers, economisers, and pumps, £2,026; W. B. Haigh & Co., Limited, for steam pipes, amounting to £854; Carter Brothers & Co., Limited, for constructional steel work, £1,059 6s.; Tudor Accumulator Co., Limited, for storage battery, £1,623; Messrs. Lucy & Co., for condensing plant, £1,542 10s. 6d.

London.—The Shoreditch Vestry on Tuesday considered the following tenders for the supply of three transformers:—

Name.	Total kilos. provided for.	Total price.	Electrical efficiency.
1. Siemens Bros., Woolwich	400	£5,890	full 93 % ¾ 91 % ½ 89 %
2. Bruce Peebles & Co., Edinburgh	600	7,465	full 85 % ¾ 82 % ½ 78 %
3. Electric Construction Company, Wolverhampton (accepted).	560	7,570	full 91 % ¾ 90 % ½ 88 %

The Lighting Committee stated that after hearing the engineer, it appeared that the smallness of the output of the machines submitted in the first tender offered no advantages, whilst the third tender, although slightly higher in price than the second, was considered the best. The committee therefore recommended, and the Vestry decided to accept, the tender of the Electric Construction Company. The following tenders were submitted for ducts:—

	Price per yard. s. d.
The British Insulated Wire Company	9 0
W. Griffiths (accepted	5 10
Reid Bros.	4 10

The lowest tender was not strictly in accordance with the specification. The tender of Messrs. Steward & Menzies, amounting to £140, was accepted for the supply of steam pipes for connecting up the new boilers. The only other offer was from Messrs. Lloyd & Lloyd, who quoted £149.

Melbourne.—The *British Australian* says that the City Council recently met and discussed tenders for the alterations and extension of the electric lighting of the city, and, after due deliberation, the following were accepted:—Boilers and economisers, Babcock and Wilcox, £6,604; engines, dynamos, equalisers, boosters and switchboard, Thos. Parker, £22,337; cables and joint boxes, the British Insulated Wire Company, £27,348 5s. 4d.; the total of the tenders being £55,000. There were about 45 tenders.

Paddington.—There were 11 tenders sent in to the Vestry for alteration to the electric lighting arrangements at the Public Baths. They ranged from £153 to £795, and the lowest tenderer, Mr. Harnden, of Harrow-road, was successful.

FORTHCOMING EVENTS.

Friday, June 8th.—At 5 p.m. Physical Society. Agenda: (1) "On the Magnetic Properties of Iron and Aluminium Alloys," Part II., by Dr. S. W. Richardson; (2) "Note on Crystallisation produced in Solid Metal by Pressure," by Mr. W. Campbell; (3) "On the Viscosity of Mixtures of Liquids and of Solutions," by Dr. C. H. Lees.

Monday, June 11th.—At 7.30 p.m. Society of Engineers. Meeting at the Royal United Service Institution, Whitehall. Paper on "Notes on Electric Traction," by Mr. Algernon Hamo Binyon. Synopsis:—

London traffic compared with that of other cities—Overhead trolley system—Power distribution—Sub-stations—Combination of electric lighting and traction plant—Batteries—Engines—Switchboards—Fuses—Circuit breakers—Trucks—Motors—Power consumption of cars—Different systems of rail bonding—Continuous rail—Electric welded—Cast welded—Plastic bonds—Copper bonds. The Paper will be illustrated by diagrams, lime light views, and models.

Wednesday, June 20th.—Convention of the Municipal Electrical Association opens at Huddersfield.

NOTES.

The Institution of Mechanical Engineers.—The summer meeting of this Institution will be held in London, commencing on Wednesday, June 27th. An interesting feature of the gathering is the anticipated presence of a number of members of the American Society of Mechanical Engineers, who will be visiting this country at the time. Among the papers down for reading are the following:—"Recent Locomotive Practice in France," by M. Edouard Sauvage, of the Western Railway of France; "Polyphase Electric Traction," by Prof. C. A. Carus-Wilson; "Observations on an Improved Glass Revealer, for studying Condensation in Steam Engine Cylinders and Rendering the Effects Visible," by Mr. Bryan Donkin. There is to be a continuation of the adjourned discussion on "Road Locomotion," in connection with which Prof. Hele Shaw, F.R.S., will read a short supplementary paper dealing with the recent trials. Various engineering and other works will be visited on the 27th, 28th, and 29th inst., and these include the Davies Street and Millbank stations of the Westminster Electric Supply Corporation, Messrs. Doulton's pottery works at Lambeth, the Bankside station of the City of London Electric Lighting Company, Messrs. Thorneycroft's works at Chiswick, and Messrs. Willans & Robinson's works at Rugby.

Personal.—The Leith Electrical Lighting Committee recommends the Town Council to appoint Mr. J. G. Scott, Whitehaven, as electrical engineer in place of Mr. Bryson, resigned.

Mr. G. L. Maben, of the Belfast Corporation electricity works, has been appointed chief assistant electrical engineer at Bradford. The Belfast staff presented him with a pair of gold sleeve links with monogram.

Mr. W. S. Clark, electric lighting accounts clerk, Vestry of Islington, has been appointed by the Shoreditch Vestry as chief clerk and book-keeper in the electric lighting department. Mr. C. B. Holdsworth, of Bradford, who was originally selected to fill the position, recently withdrew his application on receiving increased remuneration to remain at Bradford.

The Barrow Corporation has raised the salary of Mr. Burnett, the electrical engineer, to £300 per annum.

Mr. H. E. McKrell, late London manager to Isidor Frankenburg, of Salford, has commenced business at 83, Queen Victoria Street, E.C., as manufacturer's agent and supplier of all classes of electrical goods. Vulcanised rubber, wires and cables, will be made a speciality.

Messrs. Johnson & Phillips' electric cable works inform us that Mr. T. M. Harvey has rejoined their staff.

Mr. A. Nichols Moore, of the Blackpool and Fleetwood Tramroad Company, has been appointed an assistant engineer on the staff of the Sheffield Corporation Tramways.

Lectures.—Prof. Taylor Jones will, in October, begin a systematic course of instruction in electrical measurement and practical electricity, for students. See our "Official Notices" pages this week.

Electric Lighting of Inverness.—As we go to press the following letter comes to hand from Mr. E. G. Craven, of Edinburgh:—"As my name continues to occupy a somewhat prominent place both in the Technical Press and the various local journals of Inverness, I feel that a policy of absolute silence on my part may be liable to misinterpretation. May I therefore be allowed to trespass on your space to the limited extent of pointing out that I have invited the most searching inquiry into the manner in which I have dealt with the tenders for the electric lighting of Inverness, and that I await with equanimity the result of that investigation, whether carried out by an impartial committee of the Town Council, or in the Court of Session (the Supreme Court of Judicature of Scotland). All I ask is that your readers, who have hitherto heard but one side of the question, may reserve judgment until they have heard both."

The Manchester Electricity Works.—"The position and policy of the Electricity Committee were subjected to severe criticism. . . . . The Electricity Committee was arraigned for mismanagement and incompetency; its financial position, it was stated, was such as required a strict investigation. . . . . The Electricity Committee, on Thursday, decided to appoint a sub-committee to inquire into and report upon the entire administration of the department, and the following were chosen as the members of it:—Alderman Higginbottom, Councillors Batty, Bowes, Boyle, Dr. Bishop, Lambert, and Phythian."—*Manchester City News, June 2nd*, 1900.

Wireless Telegraphy.—The *Daily Mail* says that the French Government has decided to equip the ships of the Mediterranean Squadron with wireless telegraphy installations. This decision is the result of a series of experiments which have shown the value of the system in connection with coastal defence.

Electric Tramway Plant for Sale.—The Leeds Corporation is open to receive tenders for the purchase of Fowler engines, Greenwood & Batley dynamos, switchboards, and accessories, all at present in use in connection with the electric tramway system. The plant will be available for removal about February, 1901. See "Official Notices" to-day.

Correction.—We are asked to say that the fee payable to the French Committee by those who wish to take part in the Electrical Congress at Paris is 20 francs, not 40, as stated last week.

Appointments Vacant.—A demonstrator of electrical engineering is wanted at King's College, London. See "Official Notices" to-day.

An assistant lecturer in physics and electrical engineering is required at the Battersea Polytechnic after September. Salary £150 to £180. See "Official Notices" to-day.

Imperial Telegraphic Communication.—We read in the *Times* that the Eastern and Eastern Extension Telegraph Companies have printed a full report of the debate in the House of Commons on May 22nd on Imperial telegraphic communication. They issue with this a paper of remarks upon the points raised—remarks naturally directed against the arguments of those who led the attack upon the companies.

Correspondence.—Two letters have come to hand, too late for insertion in this issue, from Mr. S. F. Walker, on "The Protection of Insulated Wires" and "Electrical Engineers in the Royal Navy."

The Pacific Cable Scheme.—Reuter's agent at Sydney says that, in reply to a telegram from Mr. Chamberlain, Mr. Lee, the Colonial Secretary, has telegraphed that the Government of New South Wales agreed to the recommendations of the Pacific Cable Committee, and urged that the work should be pushed on as expeditiously as possible.

REVIEW.

Hydraulic Power Engineering. By G. Croydon Marks. London: Crosby Lockwood & Co. 1900.

Books on hydraulic engineering are too frequently little better than illustrated catalogues, probably because there are few subjects so difficult to treat simply as that of hydraulic engineering, and so little is known of the machinery employed.

From this reproach the book before us is free. It contains descriptions of actual hydraulic machines, and deals with hydraulic rams, the flow of water through pipes and channels, hydraulic lifts and cranes, baling presses, riveting machinery, pumps, turbines, water wheels, and hydraulic engines, but, curiously enough, it makes no reference to the centrifugal pump. So much has been written on centrifugal pumps, and to such a poor purpose—for no one seems to know anything about them—that perhaps our author did not care to join in, and he has left the pump severely alone.

In such machines as are described, however, the vital parts, those in which the operation of the machine is really affected, are illustrated in great detail, amongst these being the hydraulic jack, one of the most useful, and for general use most unreliable of appliances. It would be a great boon to the engineering world if someone would contrive a hydraulic jack that would not quit work in the hands of, we were going to say, the ordinary everyday labourer, but we might have said, in the hands of the skilled mechanic, and it would be a fine achievement to discover a substitute for the hat or the **U** leather packing that seems indispensable to hydraulic rams. It may be that a great deal of the trouble with leathers is due to the use of iron rams, and that brass or copper rams would produce great improvement; and it is not necessary that a light copper skin need make very serious difference in the cost of a hydraulic jack. The author very properly draws attention to the necessity of brass or gun-metal linings on which leather packings have to work, and all practical men will agree with him that the neglect of this precaution has caused the waste of thousands of pounds from the breakdown of leather packings through the rough wear of cast-iron.

Separate treatment is accorded to details of general use, such as pipe joints, which, for heavy pressure, require careful design and treatment. In hydraulic work using very heavy pressure, it is essential that the packing of joints be such as not to be capable of being blown out, and it must, therefore, be suitably confined on all sides. Both the advantages and disadvantages of water arise from the simple fact that practically it is incompressible. Hence arises its safety for heavy pressures, for being devoid of expansive property, there can be no flying apart of ruptured vessels. An atmosphere of pressure reduces the bulk of water to the extent of only 1 part in 20,000.

Many useful notes are made throughout the book, serving to warn the designer off dangerous ground. We are glad to see that the author accepts the dynamic theory of load action in stress production as enunciated by Fairbairn, and further illuminated by Wöhler and Spangenberg. We doubt, however if the theory has received the attention of bridge engineers to the extent it deserves. American bridge men, especially, are apt to deride the theory as too far drawn for practice, yet the unit stresses they find themselves compelled to adopt by experience, are in themselves a sufficient evidence of the truth of the theory.

The supply of hydraulic power in London and other cities must have a stimulating effect on hydraulic machine construction generally, and engineers will find the book useful in their work. It is well printed, and clearly illustrated.

NEW COMPANY REGISTERED.

Charing Cross and City Electric Company, Limited (66,081).—This company was registered on May 28th, with a capital of £300,000 in £5 shares (20,000 preference), to promote the use of electricity for light, heat, motive power, manufacturing and other purposes, to construct electrical works, plant, machinery, and apparatus, and to carry on the business of electricians, mechanical and electrical engineers, suppliers of electricity, metal founders, workers, and merchants, wire drawers, metallurgists, &c. The first subscribers are:—W. F. Fladgate, 2, Craig's Court, Charing Cross, S.W., chairman of Charing Cross and Strand Electric Supply Corporation, Limited, with 200 shares; G. H. B. Glasier, 7, St. James Street, S.W., director of Charing Cross and Strand Electric Supply Corporation, Limited, with 200 shares; S. Gatti, Adelaide Gallery, Strand, W.C., director of Charing Cross and Strand Electric Supply Corporation, Limited, with 200 shares; R. Chadwick, 34-5, St. Martin's Lane, W.C., director of Charing Cross and Strand Electric Supply Corporation, Limited, with 200 shares; J. M. Gatti, Adelaide Gallery, Strand, director of Charing Cross and Strand Electric Supply Corporation, Limited, with 200 shares; G. W. Finch, 22, Queen Anne Street, W., solicitor, with 1 share; and R. Gatti, 10, Bedford Square, W.C., merchant, with 1 share. The number of directors is not to be less than five nor more than 10; the first are William F. Fladgate, George H. B. Glasier, Stefano Gatti, Richard Chadwick, and Joannes M. A. Gatti; qualification, £1,000; remuneration, £1,000 per annum, divisible.

SUPPLY STATION ACCOUNTS.

Hull Corporation Electricity Accounts.

In commenting upon the accounts of the Kingston-upon-Hull electricity supply undertaking last year, we remarked that the results were very favourable. The effect of two stations has apparently been to raise the costs, capital, and, therefore, sinking fund and interest, and accordingly, to diminish the net profit. We intentionally emphasise the word "apparently," because the enhanced market prices must have had a good deal to do with coal costs, for example. The Dagger Lane station was opened in January, 1893, while the new, or Sculcoates Lane station, was started in October, 1898. It, therefore, assisted in the heavy load of the winter of that year without having had to carry the standing charges for the summer season, when its additional plant would not have been fully employed.

General Statement.

	1898.	1899.	Increase.
Total capital expenditure ...	£94,959	£133,802*	£38,843
Number of units sold	749,690	940,192	190,502
Maximum KW. demanded ...	1,075 KW.	1,405 KW.	330 KW.
Gross revenue	£16,333	£19,291	£2,958
Gross profit	£8,328	£8,660	£332
Average price per unit sold ...	4·98d.	4·69d.	−·29d.

* This figure is reduced to £131,990 by the instalment written off (or depreciation of) meters (capital account).

As we anticipated last year, the price per unit has been brought well below 5d. In 1897 it stood at 5·12d., being reduced by ·14d. in 1898, and by ·29d. in 1899 to 4·69d. per unit. Meter rents show a slightly augmented figure, but on the gross revenue the drop per unit sold is nearly ¼d. Sundry receipts include service connections, testing installations, &c., on consumers' premises, and an improver's premium.

Revenue Statement.

	1898. Gross.	1898. Per unit.	1899. Gross.	1899. Per unit.	Increase.
Sale of current ..	£15,546	4·98d.	£18,390	4·69d.	−·29d.
Meter rents, &c. ..	456	·14d.	617	·16d.	+·02d.
Supply of lamps, &c.	...	...	...	...	...
Sundry	331	·11d.	284	·07d.	−·04d.
Gross revenue	£16,333	5·23d.	£19,291	4·92d.	−·31d.

The costs sheet shows an increase in most of its constituent items. Thus coal is responsible for nearly ¼d., and as the rises in oil, waste, &c, and in wages balance the fall in repairs, this figure appears as the increase in works' costs. Establishment charges and repairs have been reduced in the gross amounts, and the former assists to reduce the upward tendency in works' costs, bringing total costs to only ·15d. over 1898. Rent, rates and taxes are very heavy, and it looks as if the works were being penalised, because they earned a profit.

Costs of Production.

	1898. Gross.	1898. Per unit.	1899. Gross.	1899. Per unit.	Increase.
Coal	£2,034	·65d.	£3,398	·87d.	+·22d.
Oil, waste, water and engine room stores.	298	·09d.	416	·10d.	+·01d.
Salaries and wages incurred in generation and distribution.	1,561	·51d.	2,455	·63d.	+·12d.
Repairs and maintenance of buildings, engines, boilers, dynamos, &c.	1,688	·54d.	1,624	·41d.	−·13d.
Works' cost ...	£5,601	1·79d.	£7,893	2·01d.	+·22d.

Rent, rates and taxes	845	·27d.	1,115	·28d.	+ 01d.
Management expenses, salaries of managing engineer, secretary, clerks, &c,	965	·31d.	1,155	·30d.	— 01d.
General establishment charges, stationery and printing, law charges and insurance	594	·19d.	468	·12d.	— 07d.
Other expenses	...	...	...	...	...
Total costs	£8,005	2·56d.	£10,631	2·71d.	+ 15d.

Interest and sinking fund charges in 1897 took £2,970, in 1898 over £4,820, and in 1899 absorbed £6,730, or an increase last year of nearly £2,000. Owing to the increased costs and reduced price per unit sold, the net profit has fallen from £3,506 to £1,924. In 1898 £1,000 was paid out of gross profits to depreciate the item of meters in the capital account, and to this a further sum of £812 was added last year.

PROFIT STATEMENT.

	1898.	1899.
Interest on loans	£2,267	£3,230
Sinking fund for repayments and depreciation of capital	2,555	3,506
Net profit carried forward	3,506	...
" " to reserve fund	...	1,924
Gross profit	£8,328	£8,660

Belfast Corporation Electricity Accounts.

THE accounts for last year recently issued show that the Belfast Corporation electricity undertaking is making most satisfactory progress. Last year we dealt with the accounts covering the transition period between the old and new order of things. Mr. Victor A. H. M'Cowen, the borough electrical engineer, has every reason to be satisfied with the results attained by supply from his new steam-driven station, opened in July, 1898.

GENERAL STATEMENT.

	1898.	1899.	Increase.
Total capital expenditure ...	£96,277	£138,394	£42,117
Number of units sold	356,526	622,486	265,960
Number of lamps connected ...	38,500	51,500	13,000
Gross revenue	£8,225	£11,679	£3,454
Gross profit	£3,882	£5,936	£2,054
Average price per unit sold ...	5·41d.	4·36d.	—1·05d.

The average price per unit sold was over 6d. in 1897, being reduced by ¾d. in 1898, and, as shown above, by over 1d. in 1899. The increase in gross revenue in 1898 as compared with 1897 was nearly £3,000, and, as the increase is now nearly £3,500, there ought to be abundant custom for the new steam station to handle.

REVENUE STATEMENT.

	1898. Gross.	1898. Per unit.	1899. Gross.	1899. Per unit.	Increase.
Sale of current ..	£8,039	5·41d.	£11,308	4·36d.	—1·05d.
Meter rents, &c. ..	171	·12d.	316	·12d.	·00d.
Supply of lamps ..	12	·01d.	51	·02d.	+ 01d.
Sundry fees, &c. ..	3	·00d.	4	·00d.	·00d.
Gross revenue	£8,225	5·54d.	£11,679	4·50d.	—1·04d.

The costs are particularly satisfactory. The only item over which the engineer has no control—rent, rates, &c.—shows a slight increase per unit. As the gross sum is more than doubled it is evident the financial department of the Corporation has been able to have its way here. To reduce fuel—*i.e.*, coal and gas—by ¾d. is an especially creditable performance. The total costs have been brought down to 2½d., nearly ¾d. less than in 1898.

COST OF PRODUCTION.

	1898. Gross.	1898. Per unit.	1899. Gross.	1899. Per unit.	Increase
Coal and gas	£1 583	1·07d.	£1,754	·67d.	—·40d.
Oil, waste, water, and engine room stores.	213	·14d.	247	·10d.	—·04d.
Salaries and wages incurred in generation and distribution.	1,156	·78d.	1,477	·57d.	—·21d.
Repairs and maintenance of buildings, engines, boilers, dynamos, &c.	291	19d.	457	·18d.	—·01d.
Works' costs	£3,243	2·18d.	£3,935	1·52d.	— 66d.
Rent, rates and taxes ..	305	·20 1.	724	·28d.	+·08d.
Management and expenses, salaries of managing engineer, secretary, clerks, &c.	383	·26d.	534	·20d.	—·06d.
General establishment charges, stationery and printing, law charges and insurance	391	·26d.	539	·21d.	—·05d.
Other expenses	21	·02d.	11	·00d.	—·02d.
Total costs ...	£4,343	2 92d.	£5,743	2·21d.	— 71d.

The proportion of units generated by gas and coal is shown as follows:—

	1897.	1898.	1899.
Units generated by gas.	201,832 at 1·30d. per unit.	195,000 at 1·22d. per unit.	22,000 at 3·019d. per unit.
Units generated by coal.	...	161,526 at ·88d. per unit.	600,486 at ·557d. per unit.

The following figures are interesting, showing what may be expected of a battery and low tension system:—

	1896. Per cent.	1897. Per cent.	1898. Per cent.	1899. Per cent.
Total efficiency ...	93·8	89·2	89·4	88·4
Loss in batteries...	3 9	5·4	5·3	6 2
Loss in mains ...	2·3	5·4	5 3	5·4

In the Corporation accounts the balance brought from last year is shown as £533. To this is added the gross profit £5,936, and after allowing for interest and sinking fund charges, £2,655 is carried forward to next year's account. It will be seen below that the net profit for last year is five times what it was in 1898.

PROFIT STATEMENT.

	1898.	1899.
Interest on loans	£2,786	£2,837
Sinking fund for repayments	175	976
Hire of gas engines	518	...
Net profit carried forward	402	2,123
Gross profit	£3,881	£5,936

CITY NOTES.

The Telegraph Manufacturing Company, Limited.

THE ordinary general meeting of the shareholders of this company was held on Friday last at the Law Association's Rooms, Liverpool.

Mr. JAMES TAYLOR, chairman of the board of directors, presided, and in moving the adoption of the report and accounts, which were accepted as read, remarked that it was a great pleasure to the directors to meet the shareholders with such a satisfactory increase in their business and profits. Their gross profit for the past year amounted to £41,284, which was an increase of £13,012 over the figure for the previous year. During the year also their property and assets, including goodwill, had increased from £127,142 to £145,870 in consequence of extended works, and the purchase of 10 acres of land adjoining their works, and the railway at Helsby, which they believed would prove a very valuable acquisition. After deducting depreciation, which was off prime cost, the total of their plant and buildings, &c., now stood at £138,842; the stock-in-trade stood at about £84,000, which was rather large, but necessitated by the frequent demands for immediate supply. They have a large stock at the Cape, of which they hoped to be able to dispose quickly now that hostilities were ceasing. Out of the balance at their disposal they proposed to add £3,887 to the depreciation account and £17,500 to the reserve fund, increasing it to £27,500, which on a capital of £200,000 was not bad for a company with practically less than two years working. There was also £4,883 for preference dividend, and in addition to an interim dividend of 3s. per share they now proposed 7s. per share and a bonus of 2s., making in all 12 per cent. for the year on the ordinary shares. This satisfactory result had been brought about by the loyal co-operation of all the staff.

Mr. CROSSLAND TAYLOR seconded the resolution which was unanimously agreed to.

The proceedings then became special.

The CHAIRMAN moved that the capital of the company be increased to £300,000 by the creation of 20,000 additional ordinary shares of £5 each, ranking for dividend and in all other respects with the existing ordinary shares of the company. He added that the immediate issue would be 5,000 shares at a premium of £4 per share, the existing shareholders to have the first option of taking them up. The amount of the premium, £20,000, would be added to the reserve fund. The increased capital was required through the large and rapid extension of the business of the company.

Mr. JOHN SHAW, who seconded, said his 20 years' experience of electrical industries convinced him that the company had a very prosperous future before it.

The resolution was carried unanimously, and a hearty vote of thanks to the chairman and directors closed the proceedings.

Castner-Kellner Alkali Company.

MR. WM. MATHER, M.P., presided at the meeting of this company held at Cannon Street Hotel last week, and in moving the adoption of the report said, according to the *Times* report, that the working of the company's process was in all respects what could be desired,

and experience had enabled it to be improved year by year in important features. This strengthened their position, apart from the protection afforded by the patents. The outcome of the year's trading was a gross profit of £59,486, out of which £11,273 had been expended in repairs, renewals, and special improvements of the working plant. The net profit was £45,398, to which had to be added £5,341 brought forward. An interim dividend at the rate of 8 per cent per annum had been paid for the six months ended September 30th last, amounting to £12,000, and debenture and loan interest had also been met, leaving an available balance of £32,045. Out of this it was proposed to pay a further dividend at the rate of 8 per cent. per annum for the six months ended March 31st last, to write off the expenses of the debenture issue (£6,000), and to appropriate £10,000 for depreciation reserve account, leaving £3,767 to be carried forward. The Mathieson Alkali Company in America, with which this company were in close alliance, had become a very successful concern. As that company possessed the great advantage of cheap water power, the Niagara Falls, the development there promised to be much greater than could possibly be hoped for in this country, or, perhaps, in any country in Europe. Of course, he referred only to that branch of the Mathieson Alkali Company which was devoted to the working of the Castner process. The motion was agreed to.

Brunner, Mond & Co., Ltd.

The general meeting of this company was held on 30th ult. at Liverpool. Sir John Brunner, Bart., M.P., presided, and moved the adoption of the directors' report and balance-sheet, and dividends of 7 per cent. per annum on the preference shares and 35 per cent. per annum on the ordinary shares.

Dr. Mond seconded, and said that after 19 years' working the position and prospects of the company were stronger and brighter than ever.

The motion was carried unanimously.

Electric Construction Company, Limited.

A meeting of the debenture-holders of this company was held on Wednesday at Winchester House. The proceedings were purely of a formal character for the appointment of new trustees. Mr. Beachcroft, who presided, explained that the International Trustee Corporation, who had acted as the company's trustees in the past, had been formally wound-up for the purpose of dealing with its founders' shares. The International Assets Company had been formed and had taken over the whole of the property of the International Trustees Corporation. The necessary resolution was then passed appointing the new company trustees to the Electric Construction Company.

Stock Exchange Notices.—The Stock Exchange Committee has appointed special settling days as under:—Wednesday, June 13th.—City of London Electric Lighting Company, Limited—Further issue of 10,579 ordinary shares of £10 each, fully paid, Nos. 100,001 to 110,579, and has also ordered the under-mentioned to be quoted in the Official List:—City of London Electric Lighting Company, Limited—Further issue of 10,579 ordinary shares of £10 each, fully paid, Nos. 100,001 to 110,579; New General Traction Company, Limited—Further issue of 20,000 6 per cent. cumulative preference shares of £5 each, fully paid, Nos. 54,001 to 74,000.

Applications have been made to the committee to appoint a special settling day in and to grant a quotation to Johnson-Lundell Electric Traction Company, Limited, 40,000 shares of £5 each; Potteries Electric Traction Company, Limited, £125,000 4½ per cent. debenture stock.

Commercial Cable Company.—A quarterly dividend of 1½ per cent. on the capital stock is payable on July 2nd.

TRAFFIC RECEIPTS.

Blackpool and Fleetwood Tramroad Company.—The receipts for the week ending June 2nd, 1900, were £370 15s. 7d.; receipts for corresponding period, 1899, £387 6s. 5d.; aggregate for half-year to date, £5,897 18s. 3d.

The Bristol Tramways and Carriage Company, Limited.—The receipts for the week ending June 1st, 1900, were £3,046 12s. 9d.; corresponding period, 1899, £3,055 7s. 7d.; decrease, £8 14s. 10d.

The City and South London Railway Company.—The receipts for the week ending June 3rd, 1900, were £1,434; ditto June 4th, 1899, £960; increase, £474. Total receipts for half-year, 1900, to date, £27,753; corresponding period, 1899, £23,193; increase £4,559. Miles open June 3rd, 1900, 9½; June 4th, 1899, 8¼.

The Dover Corporation Tramways.—The receipts for the week ending June 2nd, 1900, were £185 9s. 5½d.; June 2nd, 1899, £186 7s. 11d.; decrease, 18s. 6½d. Total receipts to date, 1900, £3,587 13s. 11½d.; corresponding period, 1899, £3,446 16s. 6d.; increase, £140 17s. 5½d. Miles of track open, 1900, 3; 1899, 3. Car miles run, 1900, 4,949; 1899, 4,233. Number of cars, 1900, 11; 1899, 11.

The Dublin United Tramways Company.—The receipts for the week ending Friday, June 1st, 1900, were as follows:—D. U. T. Co., horse cars £54 5s. 8d.; ditto, electric cars, £3,412 11s. 2d.; D. S. D. Co., electric cars, £857 2s. 8d.; total, £4,323 17s. 6d.; corresponding week last year—D. U. T. Co., horse cars, £2,095 10s. 7d.; ditto, electric cars, £1,277 18s. 10d.; D. S. D. Co., electric cars, £982 11s. 1d.; total, £4,356 0s. 6d.; decrease, £32 3s. 0d. Aggregate to date, £88,973 17s. 4d.; aggregate to date last year, £76,225 18s. 10d.; increase to date, £12,747 18s. 6d. The mileage worked is 42 miles electrically, 2 miles by horses, as against 18 miles electrically, 26 miles by horses, for the corresponding period last year.

The Liverpool Overhead Railway Company.—The receipts for the week ending June 3rd, 1900, amounted to £1,362; corresponding week last year, £1,478: decrease, £126. Total traffics from January 1st to date, £31,009; corresponding period 1899, £30,326; increase, £683. Miles open, 6 57 chains.

The South Staffordshire Tramways Company.—The receipts for the week ending June 1st, 1900, were £695 7s. 9d.; June 2nd, 1899, £619 8s. 5d. Aggregate receipts for 22 weeks, £14,335 3s. 9½.; last year, £13,884 2s. 1d.

STOCKS AND SHARES.

Wednesday Evening.

The surrender of Pretoria as a market factor had been practically discounted in the Stock Exchange some days before Lord Roberts announced it officially on Tuesday. Consequently there was little or no excitement, and business has been cut into by the Bank Holiday. Under these circumstances there are but few changes noticeable in our lists. The general tone, however, is hard, and we were told the other day by one of the principal dealers in electric supply shares that he had been besieged by brokers demanding lists of electric securities, paying various rates which clients had asked for. From this it would appear that supply shares may come into favour again, and to such inquirers as we have mentioned our short tables of investments and their yields will prove valuable. Last week we dealt with the Ordinary shares of the best known companies. Here are the Preferences most familiar in the market, together with the price and the rate which they return on the investor's money:—

Preference shares.	Fixed rate.	Price.	Return.
Bournemouth and Poole	4½ per cent.	10½	£4 6 0
Brompton and Kensington ..	7 „	9	3 17 9
Brush Electrical	6 „	2½	5 13 0
Charing Cross and Strand.. ..	4½ „	5½	3 18 3
City of London	6 „	13	4 12 4
County of London	6 „	12	5 0 0
St. James's and Pall Mall	7 „	9	3 17 9

In the foregoing list the interest is cumulative in every case, except as regards the Brush and St. James's shares.

Free dealings have sprung up in the new shares issued by the Westminster Electric Company, and the price is 5½ premium, which is under the actual value of the shares, simply because proprietors prefer to sell instead of taking up their allotments. They would find the latter course much more to their profit in the long run. The renunciation letters sent out to Westminster shareholders bear a notice to the effect that before they are signed the name of the new purchaser must be filled in—this is, we understand, in accordance with the latest Somerset House enactment. One more foolish, or more calculated to interfere with business, it would be difficult for anyone except a Government official to conceive. We are able to announce that the St. James's and Pall Mall Company is preparing a new issue of £150,000 3½ per cent. Debenture stock, particulars of which will be published in a week or 10 days.

The British Columbia Electric Light Company is offering a new lot of Preference shares to holders of the existing issue. The price fixed for applications is 10½, and as the company's present shares stand at 10½, there is no great attraction in taking up the proportion of new.

Electric railway securities are receiving a little more attention than they ordinarily get. City and South London is brightening up once more, the opening of the latest extension from Stockwell to Clapham Common assisting the market. When the line from Moorgate Street to Islington is finished—and the date is said to be not very far off—the City and South London will stand some chance of repaying the confidence of its supporters.

It should be welcome news to Central London shareholders to hear that their line, commenced four years ago, is at last completed. We do not anticipate that the opening of the railway for traffic early in July will have any marked effect upon the price of the shares. The event has been anticipated for so long, that its fulfilment may even be attended by a slight decline in the quotation of Central Londons, particularly if the first receipts fail to come up to expectation.

In the manufacturing department, Callender's shares are now quoted less the dividend, bonus and new, and the deduction is about £1 per share. The Preference are also *ex* new, but the right to apply carrying so small a privilege with it, no change has been made in the quotation. At the Telegraph Manufacturing meeting it was announced that 5,000 shares of £5 each would be issued immediately at £9 per share, existing holders to have the first offer. Seeing that the present shares stand at £12 in the market, they are hardly likely to refuse their allotments. The conclusion of the war will present an excuse for companies of every description to augment their capital, and they are likely to avail themselves of it to the full.

SHARE LIST OF ELECTRICAL COMPANIES.—TELEGRAPH AND TELEPHONE COMPANIES.

Present Issue.	NAME.	Stock or Share. †	Dividends for the last three years. 1897.	1898.	1899.	Closing Quotation, May 30th.	Closing Quotation, June 6th.	Business done during week ended June 6th, 1900. Highest.	Lowest.
110,900	African Direct Telegraph, 4 % Debs.	100	...	...	...	100 —104	100 —104	...	...
125,000	Amazon Telegraph 5 % Debs., Nos. 1 to 1,250 Red. ...	100	...	...	...	85 — 90	85 — 90	...	...
875,520	Anglo-American Telegraph	Stock	3 %	£3 9s	73/6	62 — 65	62 — 65	63	62½
3,062,240	Do. do. 6 % Pref.	Stock	6 %	6 %	6 %	114½—115½	114½—115½	115½	114½
3,062,240	Do. do. Deferred...	Stock	...	18s. %	£1 7s	13½— 14½	13½— 14	...	...
44,000	Chili Telephone, Nos. 1 to 44,000	5	4 %	3 %	...	2½— 3½	2½— 3½	...	...
10,000,000$	Commercial Cable	$100	8 %	8 %	...	165 —175	165 —175	...	...
1,563,078£	Do. do. Sterling 500 year 4 % Deb. Stock Red.	Stock	...	...	...	102 —104	102 —104	...	...
16,000	Cuba Telegraph	10	7 %	8 %	7 %	7 — 8	7 — 8	...	...
6,000	Do. 10 % Pref.	10	10 %	10 %	...	16 — 17	16 — 17	...	...
12,931	Direct Spanish Telegraph	5	4 %	4 %	...	4 — 5	4 — 5	...	...
6,000	Do. do. 10 % Cum. Pref.	5	10 %	...	...	9 — 10	9 — 10	...	...
30,000	Do. do. 4½ % Debs.	50	...	...	...	101 —105%	101—105%	...	...
60,710£	Direct United States Cable	20	3½%	3½%	3 %	11½— 12	11½— 12	11⅞	11¾
120,000	Direct West India Cable, 4½ % Reg. Deb.	100	...	...	...	100 —103	100 —103	...	...
4,000,000	Eastern Telegraph, Ord. Stock	Stock	7 %	7 %	...	150 —155	150 —155	153½	151
1,795,000	Do. 3½% Pref. Stock	100	...	...	...	97 —100	97 —100	98½	...
1,432,268£	Do. 4 % Mort. Deb. Stock Red.	Stock	4 %	...	..	111 —116	111 —116	...	...
250,000	Eastern Extension, Australasia, and China Telegraph ...	10	7 %	7 %	7 %	15½— 16	15 — 15½	15½	15¼
6,700£	Do. 5 % (Aus. Gov. Sub.) Deb., 1900, red. ann. drgs., reg. 1—1,049, 3,976—4,326	100	5 %	...	...	100 —103	100 —103	...	...
26,600£	Do. do. Bearer, 1,050—3,975, 4,327—6,400	100	5 %	...	...	100 —103	100 —103	...	...
320,000£	Do. 4 % Deb. Stock	Stock	4 %	...	...	112 —117	112 —117	114	...
300,000£	Eastern and South African Telegraph, 4 % Mort. Deb., Nos. 1 to 3,000, red. 1909	100	...	...	...	100 —103	100 —103	...	...
200,000£	Do. 4% Reg. Mt. Debs. (Mauritius Sub.) 1—3,000	25	...	...	...	100 —103%	100 —103%	...	...
180,227	Globe Telegraph and Trust	10	4½%	5½%	5¼%	11½— 11⅝	11½— 11⅝	11⅝	11½
180,042	Do. do. 6 % Pref.	10	6 %	6 %	...	15½— 15¾	15½— 15¾	15¾	...
150,000	Great Northern Telegraph, of Copenhagen...	10	10 %	12½%	...	32 — 34	32 — 34	...	...
86,300	Halifax and Bermuda Cable, 4½% 1st Mort. Debs., within Nos. 1 to 1,200, Red.	100	...	...	...	100 —103	100 —103	...	...
17,000	Indo-European Telegraph	25	10 %	10 %	10 %	53 — 57	53 — 57	...	...
100,000£	London Platino-Brazilian Telegraph, 6 % Debs.	100	6 %	...	...	105 —108	105 —108	...	...
72,680	Montevideo Telephone, Limited, Ord., Nos. 1 to 72,680 ...	1	...	...	...	¼— ⅜	¼— ⅜	...	...
86,492	Do. do. 5% Pref., Nos. 1 to 86,492	1	4 %	4 %	2½%	¾— 1	¾— 1	...	...
490,000	National Telephone, 1 to 490,000	5	6 %	6 %	5 %	4⅞— 5⅛	4⅞— 5⅛	5	...
15,000	Do. 6 % Cum. 1st Pref.	10	6 %	6 %	6 %	12 — 14	13 — 15	13	...
15,000	Do. 6 % Cum. 2nd Pref.	10	6 %	6 %	6 %	11 — 13	12 — 14	...	...
250,000	Do. 5 % Non-cum. 3rd Pref., 1 to 250,000	5	5 %	5 %	6 %	5 — 5¼	5 — 5¼	5⅛	...
2,000,000£	Do. 3½ % Deb. Stock Red.	Stock	3½%	3½%	3½%	98 —101	98 — 101	100¼	98¾
171,504	Oriental Telephone and Elec., Nos. 1 to 171,504, fully paid	1	5 %	5 %	5 %	1/16— 1/16	1/16— 1/16	...	...
100,000£	Pacific and European Tel., 4 % Guar. Debs., 1 to 1,000 ...	100	4 %	...	...	102 —105	102 —105	...	...
11,839	Reuter's	8	5 %	5 %	...	7½— 8½	7½— 8½	7½	...
3,881	Submarine Cables Trust	Cert.	...	...	...	124 —129	124 —129	...	...
58,000	United River Plate Telephone	5	5 %	6 %	6 %	4⅜— 5¼	4⅜— 5	4⅜	4⅛
16,639	Do. do. 5 % Cum. Pref. Nos. 1—16,639	5	...	...	...	4⅜— 5¼	4⅜— 5¼	5⅛	...
179,947	Do. do. 5 % Debs.	Stock	..	...	...	103 —106	103 —106	...	...
200,000£	West African Telegraph, 5 % Debs.	100	%	...	...	97 —100	97 —100	...	...
30,008	West Coast of America, Nos. 1—30,000 and 53,001—53,008	2½	...	...	...	½— 1	½— 1	...	...
150,000	Do. do. 4% Debs., 1—1,500 gua. by Bras. Sub. Tel.	100	,,	...	...	100 —103	100 —103	...	...
389,731	Western and Brazilian Telegraph 4 % Deb. Stock Red. ...	Stock	...	...	...	102 —105	102 —105	...	...
207,930	Western Telegraph, Ltd., Nos. 1—207,930	10	7 %	7 %	...	14⅜— 15¼	14⅜— 15¼	15⅛	14 1/16
75,000	Do. do. 5 % Debs. 2nd series, 1906 ...	100	...	..	...	105 —108	105 —108	106	...
88,321	West India and Panama Telegraph	10	2½%	2 %	⅝ %	¾— 1	⅝— ⅞xd	⅞	...
34,568	Do. do. do. 6 % Cum. 1st Pref. ...	10	6 %	...	...	7 — 8	6½— 7½xd	...	...
4,669	Do. do. do. 6 % Cum. 2nd Pref. ...	10	6 %	...	...	6½— 7½	6 — 7 xd	...	...
80,000£	Do. do. do. 5 % Debs., Nos. 1 to 1,800	100	5 %	...	...	104 —107	104 —107	...	...

ELECTRICITY SUPPLY COMPANIES.

19,661	Brompton & Kensington Elec. Lt. Sup., Ord., 101 to 19,761	5	4 %	6 %	6 %	7 — 8	7 — 8	...	...
12,000	Do. do. 7 % Cum. Pref. ...	5	7 %	...	...	8½— 9½	8½— 9½	...	...
50,000	Charing Cross and Strand Electricity Supply	5	7 %	8 %	9 %	8½— 9¼	8½— 9½	9¼	8¾
20,000	Do. do. do. do. 4½ % Cum. Pref.	5	...	...	...	5½— 6	5½— 6	...	...
34,000	*Chelsea Electricity Supply, Ord., ...	5	6 %	6 %	6 %	6½— 7½	6½— 7½	...	...
150,000	Do. do. do. % Deb. Stock Red....	Stock	4½%	...	...	108 —111	108 —111	...	...
60,000	City of London Electric Lighting, Ord. 40,001—100,000 ...	10	10 %	6 %	4 %	9½— 10½	10 1/16	10 1/16	10
40,000	Do. 6 % Cum. Pref., 1 to 40,000	10	6 %	6 %	...	12 — 13	12½— 13½	13⅛	...
400,000	Do. 5 % Deb. Stock, Scrip. (iss. at £115) all paid	...	5 %	...	...	122 —127	124 —129	...	...
40,000	County of Lond. & Brush Prov. Elec. Ltg., Ord. 1—40,000	10	nil	nil	4 %	9½— 10½	9 1/16	9 1/16	...
20,000	Do. do. do. 6 % Pref., 40,001—60,000	10	6 %	6 %	...	11½— 12½	11½— 12½	...	...
200,000	Do. 4½ % Deb. Stock, Prov. Certs (all paid) Rd. ...	...	...	...	...	110 — 113	110 —113	...	...
26,100	Edmundsons Elec. Corp., Ord. Shares	5	5 %	7 %	...	4½— 5	4½— 5	...	...
75,000	Do. do. 4½ % 1st Mort. Deb. Stock ...	100	...	...	...	101 —104	101 —104	...	...
110,000	London Electric Supply Corporation, Limited, Ord. ...	3	...	...	...	1½— 2	1½— 2	...	...
49,840	Do. do. do. 6 % Pref.	5	...	6 %	...	4 — 4½	4 — 4½	...	...
250,000	Do. do. do. 4% 1st Mt. Db. Stock Rd.	Stock	...	...	...	100 —102	100 —102	101	...
85,000	Metropolitan Electric Supply, 101 to 62,500	10	6 %	5 %	5 %	13½— 14½	13½— 14½	...	...
220,000£	Do. 4½ % First Mortgage Debenture Stock	...	4½%	...	...	114 —117	114 —117	...	...
220,000	Do. 3½ % Mort. Deb. Stock Red.	Stock	...	...	...	96 — 98	97 — 99	...	...
6,452	Notting Hill Electric Lighting	10	6 %	6 %	7 %	15½— 16½	15½— 16½	...	...
40,000	St. James's and Pall Mall Electric Light, Ord.	5	14½%	14½%	14½%	14½— 15½	14½— 15½	15⅜	...
20,000	Do. do. 7 % Pref., 20,081 to 40,080	5	7 %	7 %	7 %	8½— 9½	8½— 9½	9⅛	...
12,000	Smithfield Market Elect. Supply, Ord.	5	...	...	...	2 — 2½	2 — 2½	...	...
50,000	Do. do. 4 % Deb.	100	...	...	...	85 — 95	85 — 95	...	...
65,000	South London Electricity Supply, Ord.	5	...	...	...	4 — 4½	4 — 4½	...	...
79,900	Westminster Electric Supply, Ord.. 101 to 80,000 ...	5	12 %	12 %	13 %	14½— 15½	13½— 14½	15 3/16	14⅞

* Subject to Founder's Shares.
† Quotations on Liverpool Stock Exchange.
Unless otherwise stated all shares are fully paid.
‡ Dividend is paid in deferred share warrants, profits being used as capital
Dividends marked ¢ are for a year consisting of the latter part of one year and the first part of the next.

SHARE LIST OF ELECTRICAL COMPANIES—*Continued.*

ELECTRICAL RAILWAY, MANUFACTURING, AND INDUSTRIAL COMPANIES.

Present Issue.	NAME.	Stock or Share.	Dividends for the last three years. 1897.	1898.	1899.	Closing Quotation May 30th.	Closing Quotation June 6th	Business done week ended June 6th, 1900. Highest.	Lowest.
65,000	Aluminium shares, Nos. 1—65,000	1	10 %	20 %	...	2⅜— 3¼	2⅜— 3¼	...	...
90,000	Do. 4½ % 1st Mort. Deb. Stock Red.	Stock	...	...	...	96 —101	96 —101	...	...
30,000	British Electric Traction	10	...	6 %	...	15½— 16½	15½— 16½	...	...
50,000	Do. do. 6 % Cum. Pref.	10	...	...	...	12 — 13	12 — 13	12⅝	12⅝
200,000	Do. do. 5 % Perpetual Debenture Stock	Stock	...	...	...	124 —127	124 —127	126	125½
85,000‡	†British Electric Works Co., Ord. £1 shares, 50,001—135,000	...	...	...	...	1/8— 1	1/8— 1	...	...
50,000	† Do. do. 6 % Cum. Pref., 1—50,000	...	...	...	...	13/16— 15/16	13/16— 15/16	...	...
500	† Do. do. 4½ % 1st Mort. Deb.	100	...	...	...	99 —101	99 —101	...	...
40,000	British Insulated Wire Ord., Nos. 1 to 40,000	5	15 %	15 %	20 %	11 — 12	11 — 12	...	...
27,500	Do. do. 6 % Cum. Pref. Nos. 1 to 27,500	5	...	...	...	6 — 6⅛	6 — 6⅛	...	...
90,000	Brush Elecl. Engng., Ord., 1 to 90,000	3	3 %	5 %	...	1⅝— 2	1⅝— 2	...	...
90,000	Do. do. Non-cum. 6 % Pref., 1 to 90,000	2	6 %	6 %	...	2 — 2¼	2 — 2¼	...	...
125,000‡	Do. do. 4½ % Perp. Deb. Stock	Stock	...	...	...	109 —114	109 —114	...	...
50,000	Do. do. 4½ % 2nd Deb. Stock Red.	Stock	...	...	...	103 —105	103 —105	...	...
20,000	Callender's Cable Construction shares, Nos. 1—20,000	5	12½ %	15 %	15 %	14½— 15½	13½— 14½	13¾	...
20,000	Do. do. 5 % Cum. Pref.	5	...	...	...	5½— 6	5½— 6	...	...
90,000	Do. do. 4½ % 1st Mort. Deb. Stock Red.	Stock	...	...	...	112 —116	112 —116	...	...
213,533	Central London Railway, Ord. Shares	10	...	...	...	10 — 10⅛	10 — 10⅛	10⅜	...
61,033	Do. do. Pref. half-shares	5	...	...	...	4⅜— 5¼	4⅜— 5¼	...	...
71,447	Do. do. Def. do.	5	...	...	...	5 — 5⅛	5 — 5⅛	...	...
855,000	City and South London Railway	Stock	1⅞ %	2⅛ %	1⅞ %	61 — 64	65 — 68	67	65
37,500	Do. do. Ord. shares, Nos. 22,501 to 60,000	10	...	...	...	5½— 6½	6 — 7	...	...
32,098	Crompton & Co., Nos. 1 to 32,098	3	...	6 %	...	3½— 4	3½— 4	...	...
100,000	Do. 5% 1st Mort. Reg. Debs., 1 to 900 of £100, and 901 to 11,000 of £50 Red.	...	...	...	...	100 103	100 —103	...	...
99,261	Edison & Swan Utd. El. Lgt., "A" shares, £3 pd. 1 to 99,261	5	6 %	6 %	...	2 — 2⅛	2 — 2⅛	...	...
17,139	Do. do. do. "A" Shares, 01—017,139	5	6 %	6 %	...	3½— 4⅛	3½— 4⅛	...	...
344,023	Do. do. do. 4 % Deb. Stock Red.	100	...	...	...	93 — 95	93 — 95	...	...
112,100	Electric Construction, 1 to 112,100	2	6 %	6 %	...	2 — 2⅛	2 — 2⅛	...	...
25,000	Do. do. 7 % Cum. Pref., 1 to 25,000	2	7 %	7 %	...	2⅜— 3⅛	2⅜— 3⅛	...	...
140,800	Do. do. 4% Perp. 1st Mort. Deb. Stock	Stock	...	...	...	103 —106	103 —106	...	...
9,600‡	Greenwood & Batley, 7 % Cum. Pref., 1 to 9,600	10	7 %	7 %	...	10 — 11	10 — 11	...	...
30,000	Henley's (W. T.) Telegraph Works, Ord.	5	12 %	14 %	15 %	13½— 14½	13½— 14½	...	...
30,000	Do. do. do. 4½ % Pref.	5	7 %	7 %	...	5½— 5⅝	5½— 5⅝	...	...
50,000	Do. do. do. 4½ Mort. Deb. Stock	Stock	4½ %	...	...	110 —114	110 —114	...	...
50,000	India-Rubber, Gutta-Percha and Telegraph Works	10	10 %	10 %	...	21 — 22	21 — 22	21⅝	21⅜
800,000	Do. do. do. 4 % 1st Mort. Debs.	100	...	...	...	100 —103	100 —103	...	...
37,500	†Liverpool Overhead Railway, Ord.	10	3½ %	3½ %	3⅜ %	9⅛— 9¼	9⅛— 9⅜	...	...
10,000	† Do. do. Pref., £10 paid	10	5 %	5 %	5 %	13 — 13½	13¼ — 13½	...	...
37,350	Telegraph Construction and Maintenance	12	15 %	15 %	15 %	34 — 38	34 — 38	36½	...
150,000	Do. 4 % Deb. Bds. Nos. 1 to 1,500 Red. 1909	100	...	...	...	102 —105	102 —105	...	...
20,000	Telegraph Manufacturing, Ord. Nos. 1 to 20,000	5	...	8 %	12 %	11½— 12½	11½— 12½	...	...
20,000	Do. do. 5% Cm. Prf. Nos. 1 to 20,000	5	...	...	...	5½— 6	5½— 6	5⅞	...
540,000‡	Waterloo and City Railway, Ord. Stock	100	...	3 %	3 %	101 —104	100 —103	102	...

† Quotations on Liverpool Stock Exchange. ‡ Unless otherwise stated all shares are fully paid.

LATEST PROCURABLE QUOTATIONS OF SECURITIES NOT OFFICIALLY QUOTED.

*Birmingham Electric Supply, Ordinary £5 (fully paid) 8—10.
Brompton and Kensington, 4½ %, Debentures of £100, 104—106.
National Electric Free Wiring, 12/6 paid. ⅜—½.
Oldham, Ashton, and Hyde Electric (£10 pd.), Ord., 17½—18½.
Do. do. Pref. (£10 pd.), 10½—10¾.
Kensington and Knightsbridge Electric Lighting, Ordinary Shares £5 (fully paid) 12—13; 1st Preference Cumulative 6 %, £5 (fully paid), 7 — 8. Debentures, 102—105. Dividend, 1899, on Ordinary Shares 11 %.
*T. Parker, £10 (fully paid), 18.

* From Birmingham Share List.

Bank rate of discount 3½ per cent. (May 24th, 1900).

MARKET QUOTATIONS, Wednesday, June 6th.

CHEMICALS, &c.	This week.	Last week.	Inc. or Dec.
a Acid, Hydrochloric .. .. per cwt.	5/-	5/-	..
a " Nitric .. .. .. per cwt.	23/-	23/-	..
a " Oxalic .. .. .. per cwt.	33/-	33/-	..
a " Sulphuric .. .. .. per cwt.	5/6	5/6	..
a Ammoniac, Sal .. .. .. per cwt.	39/-	39/-	..
a Ammonia, Muriate (crystal) .. per ton	£34	£34	..
a " " .. .. per ton	£31	£31	..
a Bleaching powder .. .. per ton	£7	£7	..
a Bisulphide of Carbon .. .. per ton	£15	£15	..
a Borax .. .. .. per ton	£17	£17	..
a Benzole (90 %) .. .. .. per gal.	7/-	7/-	..
a " (50/90 %) .. .. per gal.	5/6	5/6	..
a Copper Sulphate .. .. .. per ton	£26	£26	..
a Lead, Nitrate .. .. .. per ton	£25	£25	..
a " White Sugar .. .. per ton	£31	£31	..
a " Peroxide .. .. .. per ton	£27 10	£27 10	..
a Methylated Spirit .. .. per gal.	2/9	2/9	..
a Naphtha, Solvent (90 % at 160° C.) .. .. per gal.	5/6	5/6	..
a Potash, Bichromate, in casks .. per lb.	4d.	4d.	..
a " Caustic (75/80 %) .. per ton	£24	£24	..
a " Bisulphate .. .. per ton	£35	£35	..
a Shellac .. .. per cwt.	68/-	68/-	..
a Sulphate of Magnesia .. .. per ton	£4 10	£4 10	..
a Sulphur, Sublimed Flowers .. per ton	£6	£6	..
a " Recovered .. .. per ton	£5 10	£5 10	..
a " Lump .. .. .. per ton	£5	£5	..
a Soda, Caustic (white 70 %) .. per ton	£10 15	£10 15	..
a " Crystals .. .. .. per ton	£8	£8	..
a " Bichromate, casks .. per lb.	8½d.	8½d.	..
METALS, &c.			
Aluminium Wire, in ton lots .. per ton	£224	£224	..
b " Sheet, in ton lots .. per ton	£191	£191	..
p Babbitt's metal ingots .. .. per ton	£80 to £150	£80 to £150	..
c Brass (rolled metal 3' to 12') basis per lb.	8½d.	8½d.	..
Tube (brazed) .. .. per lb.	10½d.	10½d.	..
c " " (solid drawn) .. per lb.	9d.	9d.	..
c " Wire, basis .. .. per lb.	8¼d.	8¼d.	..
c Copper Tubes (brazed) .. .. per lb.	11½d.	11½d.	..
c " " (solid drawn) .. per lb.	11½d.	11½d.	..
Copper Bars (best selected) .. per ton	£84	£85	£1 dec.

METALS, &c. (*continued*).	This week.	Last week.	Inc. or Dec.
g Copper Sheet .. .. .. per ton	£84	£85	£1 dec.
g " Rod .. .. .. per ton	£84	£85	£1 dec.
e " (Electrolytic), Bars .. per ton	£81	£81	..
e " " Sheets .. per ton	£90	£90	..
e " " Rod .. per ton	£84	£84	..
e " " H. C. wire per lb.	9½d.	9½d.	..
f Ebonite Rod .. .. .. per lb.	8/-	8/-	..
f " Sheet .. .. .. per lb.	5/-	5/-	..
m German Silver Wire .. .. per lb.	1/6	1/6	..
h Gutta-percha, fine .. .. per lb.	8/- to 8/6	8/- to 8/6	..
h India-rubber, Para fine .. per lb.	3/9½ to 3/10	3/9½ to 3/10	..
c Iron, Charcoal Sheets .. .. per ton	£18	£18	..
c " Pig (Cleveland warrants) per ton	69/6	69/6	..
c " Forgings, according to size per ton	From £11	From £11	..
c " Scrap, heavy .. .. per ton	70/- to 72/6	70/- to 72/6	..
c " Wire galvanised No. 8 .. per ton	£13 10	£13 10	..
g Lead, English Ingot .. .. per ton	£17 to £17 5	£17 to £17 3 9	inc.
g " " Sheet .. .. per ton	£18 10	£18 10	..
m Manganin Wire No. 28 .. .. per lb.	8/-	8/-	..
g Mercury .. .. per bottle	£9 10	£9 10	..
d Mica (in original cases), small per lb.	3d. to 9d.	3d. to 9d.	..
d " " " medium per lb.	1/9 to 2/9	1/9 to 2/9	..
d " " " large per lb.	3/3 to 7/3	3/3 to 7/3	..
p Phosphor Bronze, plain castings per lb.	1/1 to 1/4	1/1 to 1/4	..
p rolled bars & rods per lb.	1/1 to 1/4	1/1 to 1/4	..
p " r'l'd str'p & sheet per lb.	From 1/8	From 1/8	..
o Platinum .. .. per oz.	£3 12	£3 12	..
p Silicium Bronze Wire .. .. per lb.	10½d. to 1/1	10½d. to 1/1	..
i Steel, Magnet, acc'd'g to desc'p'n p. ton	From £15	to £40	..
i Steel, Magnet, in bars	£58	£58	..
g Tin, block .. .. per ton	£139 to £140	£141 to £141 10	dec.
g " foil .. .. per lb.	1/9	1/9	..
n " wire Nos. 1 to 16 .. .. per lb.	1/9	1/9	..
p White Anti-friction Metals—			
"White Ant" brand .. per ton	£40 to £70	£40 to £70	..
j Yarns, Cotton, Single 10lb. bundles pr lb.	8½d.	8½d.	..
j " Best Flax, 6 lea. .. per lb.	6d.	6d.	..
j " Hemp, 8 ply 10 lbs. .. per lb.	4½d.	4½d.	..
j " " Russian, 10 lbs. per lb.	5½d.	5½d.	..
j " Jute, 180 lbs. rove .. per ton	£14	£14	..
k Zinc, Sheet (Vielle Montagne bnd.) p.t.	£25 15 nett.	£27 5 nett.	30s. dec.

Quotations supplied by
a Messrs. G. Boor & Co.
b The British Aluminium Company, Ltd.
c Messrs. Thos. Bolton & Sons.
d Messrs. F. Wiggins & Sons
e Messrs. Frederick Smith & Co.

Quotations supplied by
f The India-Rubber, Gutta-Percha, and Telegraph Works Company, Ltd.
g Messrs. James & Shakspeare.
h Messrs. Jackson & Till.
i Messrs. Belling & Lowe.
j Messrs. Henry C. Yee & Co.

Quotations supplied by
k Messrs. Morris Ashby, Limited.
m Messrs. W. T. Glover & Co., Ltd.
n Messrs. P. Ormiston & Sons.
o Messrs. Johnson, Matthey & Co., Ltd.
p The Phosphor Bronze Company, Ltd.

INSTITUTION OF ELECTRICAL ENGINEERS.

THE CALCULATION OF DISTRIBUTING SYSTEMS OF ELECTRIC TRACTION UNDER BRITISH CONDITIONS.

By H. M. Sayers, Associate Member.

(*Paper read May 3rd, 1900.*)

(*Concluded from page 942.*)

APPENDIX No. II.

EXAMPLES AND TABLES OF MOST ECONOMICAL CURRENT DENSITY.

Symbols as in Appendix No. I.

$$\frac{c}{a} = \frac{t}{\cdot 045} = \sqrt{\frac{0041\ \text{R}\, p\, w}{\cdot 045}}$$

R = percentage interest charge on cables.
p = cost of one ton of copper in form of cable.
$w = \frac{657{\cdot}5}{h\,n}$, where h = equivalent full load hours of use per day, and n = cost in pence of one Board of Trade unit.

For example, let R = 9, p = £200 } R p = 1,800
h = 12, n = ·8d. } $h\,n$ = 9 6

$$w = \frac{657{\cdot}5}{9{\cdot}6} = 68\,49,$$

then t^2 = 1,800 × 68·49 × 0041 = 505·4,

and t = 22·5 = drop in volts per mile $\frac{c}{a} = \frac{22{\cdot}5}{045}$ = 500 amperes per square inch.

The equality of ohmic and interest losses is readily shown. One mile of cable of one square inch section will cost £200 × 9·1 = £1,820, and the interest on it at 9 per cent. will be £164, while the ohmic loss will be 500 × 22·5 = 1,125 watts, worth also £164 per annum; to the nearest £1 in each case.

Tables for varying values of R p and w are convenient, in the following form:—

R p = 1,200.

w	t = drop per mile.	Best density.
40	14	312
50	15·7	362
60	17·2	383

R p = 1,500.

40	15 7	362
50	17·6	392
60	19 2	427

R p = 1,800.

40	17 2	383
50	19 2	427
60	21·1	469

or a table giving values of t and best density for values of the product. R p w may be readily made and used.

APPENDIX No. III.

CALCULATIONS FOR "BOOSTED" FEEDERS.

The only special factor in these is the correct value of w. Such value should take into account the transformation loss in the booster, and the annual charges on that machine referred to its output.

If n is the cost of a Board of Trade unit at the main switchboard, and the efficiency of the booster at its average working load is $\frac{x}{100}$, the transformed units will cost $\frac{100}{x}\,n$ in energy alone.

Again, if the machine cost £a per annum in interest and depreciation, and £b per annum for attention and stores consumed per unit of average working output, these charges will add to the cost of the energy $\frac{(a+b)\ 240}{365 \times h}$ in pence per B.O.T. unit, the value of w will then be

$$w = \frac{240{,}000}{(365\,h \times n\,100) + 240\,(a+b)}{x}$$

For example, if a booster cost £15 per KW. output, and 12 per cent. is charged for interest, &c., and if it costs 10s. per annum for attention and stores, these costs amount to £2·3, or $a + b$ = 2·3, then if the set is in service 15 hours per day

$$\frac{(a+b)\ 240}{365\,h} = \frac{2{\cdot}3 \times 240}{\cdot 5475} = \cdot 11 \text{ pence.}$$

With n = ·75d. and efficiency 75 per cent., the cost per unit transformed becomes

(·75 × 1·33) + ·11 = 1·11 pence.

and $w = \frac{240}{1{\cdot}11 \times 5\,475} = 39\,5.$

The values of w so found should be used in calculating the best density of current in the "boosted" feeders.

It must be noticed that where boosters are used, as on trolley feeders, to keep the drop within certain limits, the boosters have only to supply the difference between the permitted drop and that which occurs in the feeders, and the current density found as here explained is that which should prevail in the corresponding distance beyond the point at which an unboosted feeder will give the limiting drop. Hence the total drop in the boosted feeder should be the sum of the limit, and that in the length beyond at the density here found, and the actual section of the feeder should be such as to give that drop on the actual feeder length. Thus, if the limiting drop is 50 volts, and that is given by an unboosted feeder three miles in length; whilst a boosted feeder is 4½ miles long, and should drop 15 volts in the 1½ miles excess, the proper uniform density in the whole 4½ miles should be such as to give 65 volts drop. Unless supply is given much beyond the limiting drop distance, the decrease in current density as compared with that found for direct feeders, will not be large. In track feeders, however, the "boosted" density is practically correct, as the permissible drop is always much exceeded.

The best density for secondary feeders supplied from transformers is found in the same way as for track feeders.

APPENDIX No IV.

CALCULATION FOR TRACK FEEDER, EAST OF T.

Rail resistance, ·0289 w per mile.
Drop allowed, 5 volts.
Amperes × miles constant for 5 volts = 173.
Current per car, 15 amperes. Cars passing in pairs.

From T Eastwards.

Cars.		Amp. miles.	Product.	Sum.
T to F, 5 cars, ·9 miles.	1st pair ...	... 30 × ·3 =	9	
	2nd pair ...	... 30 × ·6 =	18	
	1 at F ...	... 15 × ·9 =	13·5	
	2 on line D F	... 30 × ·9 =	27	67·5
F to G, 4 cars, 1 25 miles	1st pair ...	... 30 × 1·21 =	36 3	103·8
	2nd pair ...	... 30 × 1 83 =	54·9	158 7
	2 on line N G	... 30 × 2·15 =	64·5	223 2

As the sum is brought over the constant by the current flowing in at G from branch N G, G should be a point of change of direction. The product of amperes × miles on branch N G is 15 × 1·1 = 16·5. This added to the 158·7 at G = 175·2, a little over the limit. Hence the whole of the 30 amperes from branch N G should flow east, and the integral of ampere miles from G to feeding point should be 173 — 16·5 = 156·5, to keep N at 5 volts.

Then from G Eastwards Section G O, 4 cars.

1·5 miles long. Current flowing east 30 amperes from branch N G.

Cars.	Amp. miles.	Product.	Sum.
At G	—	16·5	—
G to 1st pair ...	30 × ·375 =	11·25	27·75
1st pair to 2nd pair	60 × ·75 =	45·00	72·75
2nd pair to O ...	90 × ·375 =	33·75	106·50

H being terminus, and only 2 cars between H and O, it is obvious that feeding point should be west of O, so sum westwards from H. H to O 1·7 m.

Cars.	Amp. miles.	Product.	Sum.
1st pair to O ...	30 × ·85 =	25·5	
O to 2nd pair G O	30 × ·375 =	11·25	36·75
2nd to 1st pair G O	60 × ·75 =	45·00	81 00

Feeding point will thus be between the 1st and 2nd pair of cars east of G. It should be exactly ·825 miles east of G. The product from this point will be 54·75 to the terminus H and to N, corresponding to 1·58 volts drop. Hence the feeding point may be 3·42 volts above earth.

The track feeder will have to carry back 120 amperes, and be 2,975 miles long. Section should be ·39 sq. in., and the drop in it will be 15 06 × 2·975 = 45 volts. But as its end may be 3 42 volts above earth, the booster will have to give only 41·58 volts, and have an output of 41·58 × 120 = 5,000 watts say.

TRACK FEEDER No. 2.

From T Westwards.

It is obvious to inspection that some current should return *vid* D and some *vid* J. The dividing points should be those at equal distance from T by each route.

On the branch D J this point is practically at the centre of its length, hence half the total current is taken as flowing each way.

On the circuit T D C I J T, it is very close to the junction, I. Hence the current returning by J will be half that on the branch, D J, and the whole of that on branches from J to I, K and L respectively, making altogether 8·5 × 15 = 127·5 amperes, which gives at once the section of the track feeder from T to J. It also follows that the potentials of points D and J should be kept equal. Find feeding points, &c., as before.

T to D, 7 cars, 2·35 miles. Branch C M, 4 cars = 60 amperes at ·35 miles from T.

Assume 1 car at D, the other 6 in pairs at ·59, 1 18 and 1 77 miles respectively from T.

CURRENT EASTWARDS TOWARDS T.

Cars.	Amp. miles.	Product.	Sum.
T to C	60 × ·35 =	21·00	
T to 1st pair ...	30 × ·59 =	17 70	38 7
T to 2nd pair ...	30 × 1·18 =	35 40	74·1
T to 3rd pair ...	30 × 1·77 =	53 10	127 2
T to D	15 × 2 35 =	35 25	162·45 = 4 7 v.
T to O, part current from branch D J	4 4 × 2 35 =	10 5	173

giving 5 volts at D.

b The British Aluminium Company, Ltd.
c Messrs. Thos. Bolton & Sons.
d Messrs. F. Wiggins & Sons
e Messrs. Frederick Smith & Co.
Telegraph Works Company, Ltd.
g Messrs. James & Shakspeare.
h Messrs. Jackson & Till.
i Messrs. Belling & Lowe.
j Messrs. Henry C. Yee & Co.
m Messrs. W. T. Glover & Co., Ltd.
n Messrs. P. Ormiston & Sons.
o Messrs. Johnson, Matthey & Co., Ltd.
p The Phosphor Bronze Company, Ltd.

CURRENT WESTWARDS FROM D.

D to C, 1·65 miles, 6 cars, passing at ·41, ·82, 1 23 miles from D, 33 amperes from branch D J also—

Cars.	Amp. miles.	Product.	Sum.
D to 1st pair ...	33 × ·41 =	13·53	
1st to 2nd pair ...	63 × ·41 =	25·83	
2nd to 3rd pair ...	93 × ·41 =	38·13	
3rd to C	123 × ·41 =	50·43	127·92 at C.

Count back from A to find equal point.
A to B, 2 miles, 3 cars, assume 1 at A, 2 in middle.

CURRENT EASTWARDS FROM A.

Cars.	Amp. miles.	Product.	Sum.
A to 1st pair ...	15 × 1 =	15	
1st pair to B ...	45 × 1 =	45	60

B to C, 1·1 miles, 2 cars, assume in middle, current of one car from branch B J. Continue summing from A.

Cars.	Amp. miles.	Product.	Sum.
B to middle ...	60 × ·55 =	33	
Middle to C ...	90 × ·55 =	49·5	142·5 at C.

This indicates feeding-point a little west of C, but as 60 amperes more enter from branches north and south of C, and C is the meeting place of four tracks, it is clearly the proper place for the feeder to tap the rails. If this point be kept at earth potential, A, the point farthest from T will be at 4·1 volts above earth.

The feeder will be four miles long, have to carry 273 amperes back, have a section of ·89 sq in., will drop 4 × 15 06 = 60·24 volts, and booster must give 273 × 60·24 = 16,445, say 17,000 watts.

TRACK FEEDER NO. 3.

Inspection of the diagram suffices to show that J must be the feeding point for this. The greatest drop thence will be on branch J K, 2·2 miles long with two cars. Assume one at K and one half way, then ampere miles K J will be 41·25 or 1·2 volts. J must then not be more than 3 8 volts above earth. This is lower than D, so that more than the half current on line J D will return by the feeder *vid* J. *Per contra* part of the current from branch I J will go *vid* I C. The assumed distribution could be obtained by splitting the feeder at J, and connecting the branches at proper points on the three lines J L, J K, J I.

No practical advantage would result, as in working the load on each feeder is regulated to keep the pilot wire indications within proper limits, by control of the booster E.M.F., and it is quite certain that the actual load and its distribution will vary widely and rapidly in any given case from any assumed distribution, consequently in a network requiring a number of track feeders it is sufficient to ensure that they shall be provided of needful section and number to enable the P.D. on the rails to be kept within limit, and refined investigation of the current distribution is likely to be labour lost.

Hence No. 3 feeder may be safely taken as tapping rails at J. It will be 2·15 miles long, carry 127·5 amperes, have a section of ·415 square inch, drop 32 4 volts, and require a booster to give 32 4 × 127·5 = 4,130, say 4,200 watts.

A FRICTIONLESS MOTOR METER.

By S. EVERSHED, Associate Member.

(*Abstract of paper read May 10th*, 1900.)

PRELIMINARY.

In the course of the last few years the author has tested some of the better known types of motor meter in general use, with the result that the lowest observed value for the moment of frictional resistance is 57 dyne cms. and the highest nearly 1,400 dyne cms., while values of from 300 to 500 dyne cms. are quite usual. All these tests were carried out upon new meters which had been carefully adjusted by the makers. In the author's meter the friction moments so far observed vary from 1·7 dyne cms. in a new meter up to 3·5 dyne cms. in one which has run for many million revolutions. These figures will, it is hoped, serve to excuse, if not to justify, the title "frictionless."

Among the many links in the long chain connecting the energy locked in the coal store of an electric power station with the work done on the consumer's premises, the supply meter is by no means the least important. Yet it has, perhaps, received less attention from the Institution of Electrical Engineers than any other essential part of an electric supply.

Is the average meter, then, so good that it needs no attention from us? Far from it; erratic meters are not unknown. One will allow a consumer to run a lamp all day for nothing, another for 30 or 40 per cent. discount. Precious energy, after having its cost ascertained to a hundredth of a penny, is positively being given away every day by sticky motor meters, unbalanced clock meters, and the like. As a set-off, one hears of meters running up a big bill when the consumer is out of town and the main switch off.

Bearing all this in mind, the author feels that a paper devoted to the description of an attempt to remove some of the more obvious defects of a particular class of meter—the motor type—together with an exhibition of the outcome of that attempt will need no apology.

MOTOR METERS.

The fundamental principle of all motor meters is very simple. The driving moment (torque) of the motor is made proportional to the power (or to the current, in a coulomb or electricity meter) being metered, and the speed of the motor is controlled by a brake whose resisting moment is proportional to the speed. Consequently the speed will be proportional to the power (or to the current), and the number of revolutions made in a given time will be proportional to the energy (or to the electricity) supplied. This was first clearly stated by Profs. Ayrton and Perry in describing their well-known energy meter, the forerunner of nearly all energy meters since invented.* Unfortunately it is easier to lay down the law than it is to make a meter obey it. A motor axle must have bearings; a current has to be led to the rotating armature either by brushes or by means of a mercury bath, and there is a counting train to be driven. All these things involve friction, and a part, often a very considerable fraction, of the available driving torque will be used up to overcome it. There are other minor difficulties, but, practically, friction is the only serious trouble in a motor meter; it limits the accuracy, and involves a good deal of wear and tear.

If one attempts to design a practicable energy meter of the type described by Ayrton and Perry, one is hampered by certain fairly definite limitations, such as cost of manufacture, drop in the current coils at full load (or power wasted in them if that is the more important item), and above all, waste of power in pressure circuit. If the full-load drop is fixed at 1 volt, and the wasted power in the pressure circuit is limited to 3 or 4 watts, it will be found that the maximum driving torque obtainable (on the assumption that the meter is to be saleable at present average prices) is something like 20,000 dyne cms., and the friction may be from 300 to 500 dyne cms. A greater driving moment is easily obtained by enlarging the armature, but only at the expense of increased weight of moving parts, and a consequent increase in friction. We shall be fairly stating the result of careful designing if we put the driving torque at 15,000, and the moment of frictional resistance at 300 dyne cms.; in other words, driving torque at full load amounts to about 50 times the frictional resistance. It will be convenient to reduce these figures to percentages by calling the full load 100, maximum driving moment 100, and the friction moment 2, arbitrary units. We may also reckon full speed of the meter as 100 revolutions per minute. Our hypothetical meter will obviously not start until the load exceeds 2. Also it will make 98 revolutions per minute at full load, since of the total driving torque of 100, 2 units are used up for friction, leaving 98 to work on the brake. Hence a table of corrections can be written down at once, on the assumption, of course, that friction is constant throughout the range of speeds contemplated. If there is no fluid friction this assumption is correct. The errors of the meter are given in Table I.

TABLE I.—ERRORS OF UNCORRECTED MOTOR METER.

Maximum Driving Torque = 100, Friction = 2. Full Speed = 100. Arbitrary units.

Driving moment M.	Friction f.	Speed numerically equal to $M - f$.	Percentage error.
2	2	0	inf.
4	"	2	− 50
10	"	8	" 20
20	"	18	" 10
40	"	38	" 5
60	"	58	" 3·3
80	"	78	" 2·5
100	"	98	" 2·0

Standard range = 1 to 3·3.

It will be observed that with such a meter the consumer gets a discount of 16 per cent. when he is taking one-tenth of full load.†

The range of a meter within specified limits of error forms the best criterion of comparison as regards accuracy, and the author proposes to call that part of the total range of a meter in which its error is within the limits imposed by the Board of Trade "the Standard Range." Hence the standard range of the hypothetical meter is 1 to 3·3 when the meter is adjusted to register correctly at full load.

CORRECTION FOR FRICTION.

It is well known that friction can be partially corrected by means of a starting coil in the pressure circuit. If to the hypothetical meter we add a starting coil whose driving moment on the armature equals 2, the errors in Table I. disappear. A new error will, however, have crept in; the meter will almost invariably run when the load is zero; lessen the strength of the starting coil, and the meter, although not quite so immoral, will still occasionally go on running when the load is off.

The author has found that a meter fixed to the brick wall of the office building at Woodfield Works would go on running all night when the driving moment was reduced to a very small fraction of that required to balance the normal average friction; and this can only be accounted for on the assumption that during what may be called the positive half periods of vibration the meter axle and commutator were to all intents and purposes frictionless.

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* Specification of Patent No. 2,642, 1882.

† Through the kindness of Prof. Ayrton, the author has been able to test an actual meter made in the manner described. Its maximum driving torque was 19,000 dyne cms., and its friction 350 dyne cms., the accuracy being therefore rather better than that shown in Table I. But this was dearly purchased at the expenditure of no less than 10 watts in the pressure circuit.

Elimination of Friction.

Instead of regarding friction as unavoidable and attempting to correct for it, the author has approached the problem from another side and endeavoured to remove the causes of friction, and so avoid the necessity for correction. These causes are, as has already been stated, (1) friction of axle bearings, (2) friction of brushes on commutator, and (3) friction of counting train and gear connecting it with the motor axle. With an ordinary vertical axle the first is nearly all due to the bottom or step bearing, which is usually a rounded steel point resting in a jewel cup. In the author's meter the pressure of the axle on the bottom bearing is reduced to a few grammes by magnetically suspending the axle, armature and brake. A top bearing is entirely dispensed with, the axle being "magnetically pivotted."

The brush friction is enormously reduced by the use of a novel form of commutator, having elastic segments, against which the edges of two light and freely pivotted wheels roll to act as brushes.

The friction of the train is entirely removed as a source of error. The train is driven by a simple electro-magnetic device, whose speed of working is controlled by the speed of the motor, although there is absolutely no mechanical connection between them.

These means have already sufficed to reduce the friction from a value between 300 and 400 dyne cms. to less than 3 dyne cms., and there is reason for believing that the limit has not yet been reached.

Early Attempts at Magnetic Suspension.

The possibility of using magnetic force to take the weight of the rotary parts of a motor meter off its bearings has, no doubt, presented itself to many minds.

In 1887 Mr. Hookham referred to the subject. A little later Mr. Ferranti turned his attention to magnetic suspension, and quite recently in America Mr. Stanley has brought out a motor meter in which the vertical axle is entirely suspended by means of the attraction of iron discs fixed on the axle and ring poles surrounding them.

The author began experimenting with magnetic suspensions a few weeks after the publication of Prof. Forbes's paper on his "windmill" meter. It occurred to him that the Forbes meter might be made nearly frictionless by magnetically suspending the axle and its vanes. A meter was made on this plan with a bar magnet placed in line with and immediately above the end of the axle, which was pivotted top and bottom; the arrangement proved quite unworkable and was abandoned. In 1891 the author, in connection with Mr. Vignoles, was working at a motor meter of the Ayrton-Perry type, in which friction was eliminated by floating the armature in water or oil. The armature was held in the centre of the vessel containing the liquid by means of a little iron rod projecting axially below the armature, with its end close to the bottom of the vessel. A bar magnet was fixed underneath the vessel, in line with the iron rod, and with its upper pole as close as possible to the bottom of the vessel. The iron rod was consequently held in the magnetic axis of the bar magnet, and the axis of rotation of the rotatory system coincided with the magnetic axis. This "magnetic pivot," as it was called, worked admirably, but the meter itself was a failure.* Another application of magnetic suspension was attempted in 1891-2 in connection with an early form of the Richards-Evershed ships' telegraph.

In a renewed attempt to make a frictionless meter of the Ayrton-Perry type, the weight of the rotary part was suspended by the attraction of a fixed solenoid surrounding the upper end of the iron axle. It was, however, not found practicable to reduce the waste of power in the solenoid below about 5 watts.

Present Form of Magnetic Suspension.

Finally, the author returned to the first idea of a simple magnetic pole fixed above an iron axle. Experience had proved that one of the worst troubles with all forms of suspension was caused by the magnetic axis not being absolutely coincident with the rotational axis, the latter being determined by the pivots. If the top pivot is removed, the axle is free to centre itself in a magnetically symmetrical fashion, and it will then rotate about the magnetic axis (fig. 1). Any directional moment due to the axle and suspending pole not being perfect figures of revolution, will be enormously reduced by diminishing the diameters of axle and pole; and with diameters not much exceeding 5 mm. the supporting pole has no measurable directing influence upon the axle. The combination of the magnetic suspension with the magnetic pivot has resulted in a perfectly practicable and very simple arrangement for relieving a step bearing of the greater part of the weight of the rotating system.

To prevent the axle from accidentally coming into contact with the supporting pole, a thin plate of non-magnetic metal (seen at *c* in fig. 1) is interposed between them. It is fixed immediately above the end of the axle, leaving a very small clearance. The supporting pole is adjusted until nearly the whole of the pressure on the step bearing is relieved. If the pressure is reduced to zero, a slight shake will jerk the axle up until it rests against the plate, where it will remain, since the upward attracting force increases as the space between axle and supporting pole diminishes. It is therefore necessary to leave a few grammes weight unbalanced so that there is sufficient gravitational force downwards to pull the axle off the end-plate, should it happen to rise into contact with it.

Essential Points in Magnetic Suspension of Meter Axles.

Our object in magnetically suspending the axle of a motor meter is twofold. It is certainly an advantage to reduce wear and tear of bearing, but primarily we desire to improve the meter as regards accuracy and waste of energy, and to that end it is essential that there should be a reduction of all the resistances to rotation other than that offered by the brake. Now, a moment's consideration shows

Fig. 1.—Present Form of Magnetic Suspension applied to a Motor Meter.

that in reducing the friction of the step bearing to zero, we may at the same time introduce a new source of friction, namely, hysteresis. This, as is well known, offers a resistance to rotation. In a dynamo or motor the hysteresis torque is there in any case, whether we suspend the armature or not, so that the relief of bearing friction by displacing the armature in the pole-pieces is a clear gain, but in the meter there is no iron core within the armature, and in order to suspend the axle in the same way a core must be put upon the axle for that purpose, thus introducing a resisting torque which did not exist before.

We thus arrive at an essential principle for magnetic suspension of meter axles: *The induction density in the magnetic devices used for support must remain absolutely constant during rotation of the axle.* This at once disposes of unsymmetrical bipolar arrangements; nothing of the nature of two poles attracting a piece of iron will serve. To secure uniform induction density in the rotating part of the magnetic circuit, the attracting pole must be a figure of revolution with its axis coincident with the axis of rotation. As an example, the attracting pole might be a ring concentric with the axle; an iron disc fixed upon the axle a little below the plane of the ring pole would be attracted upwards, and if the ring and disc could be made mechanically true and magnetically homogeneous, the induction density would be uniform in the disc and there would be no resistance to rotation due to hysteresis. In practice it is exceedingly difficult to ensure these conditions. The disc is in unstable equilibrium transversely, and there is necessarily a little clearance between the axle pivots and their bearings, the disc will always run a little out of centre; this at once raises the density at one part of the annular air-gap and lowers it on the opposite side, and during rotation the iron of the disc goes through a minute magnetic cycle, absorbing a corresponding amount of energy. The disc is also pulled sideways and causes the pivots to press against the bearings. These effects were very marked in the experimental devices already referred to, and led the author to abandon that type of suspension for the simple form finally adopted, namely, a cylindrical magnetised rod fixed with its lower end immediately above and in line with the cylindrical iron axle.

It must not be supposed that this is a complete solution of the problem; but it has proved itself to be a thoroughly practicable one, and if the diameter of the supporting pole and axle is small enough, there appears to be no trace of hysteresis, nor is any difficulty experienced in obtaining the requisite mechanical truth. Of course the position of the axle is one of unstable equilibrium in a vertical direction, the magnetic attraction increasing rapidly if the axle rises towards the supporting pole. But if means are adopted to confine the possible travel of the axle within narrow limits, it will run with very little pressure on the step bearing.

(*To be continued.*)

* It is worth mentioning that the train of this meter was to be driven by a coil with a vertical axis fixed on top of the armature and alternately attracting and repelling a magnet; an idea which has, after the lapse of nearly 10 years, been tested and proved to be entirely practicable.

THE COST OF HIGH SPEED TRAINS.

One of the topical discussions of the American Society of Mechanical Engineers was upon the cost of running high speed trains. Mr. Delano, who presented a paper on the subject, grouped the items of cost under six headings:—

(*a*) Increased fuel consumption.
(*b*) Higher grade of machinery, material, and service.
(*c*) Increased wear and tear, cost of maintenance of machinery and permanent way.
(*d*) Increased risk of accident by breakage of machinery or injury to track.
(*e*) Increased risk of accident by collision.
(*f*) Delay to ordinary traffic through the need of a clear headway for the high speed trains.

He accepts the usual formula for train resistance which is in use by the Baldwin Locomotive Works, $R = 3 + \frac{V}{6}$, where V is in miles per hour. Thus at 30 miles velocity, R is 8 lbs. per ton, and becomes 13 at 60 miles. Then the ratio of the power is, of course, that of $(8 \times 30) : (13 \times 60)$; this ratio in the present case is 8 : 26, which represents an increase of 225 per cent., the actual power developed being thus 3¼ times as much. But the mile is passed over in one-half the time at the higher speed, so that the work done per mile is as 1 to $\frac{3\,25}{2}$ or 1 : 1·625, being simply the ratio of the resistances at the various speeds.

Prof. Goss pointed out that the engines used 10 years ago on 10 or 12 car trains are now relegated to light service, and engines of twice their power do not handle trains of equal length. Of course, much of this latter fact is due to the engine weight itself. The true measure of the duty is obviously one that includes the weight hauled or carried. The modern engine has been increased in boiler capacity rather than in cylinder capacity, which again is quite consistent, for the cylinder is able to exert a greater power with the increase of speed. It is enabled to use more steam in unit time, and an increase of average speed must obviously be met by an increase of boiler capacity, for the increased speed demands steam for units of distance in a shorter time. The boiler does not benefit by the fact that a mile of resistance is overcome in the same time formerly required for, say, half a mile. In other respects the locomotive requires to be better made and fitted, needs the best of oil and fuel, and generally demands a high standard of service throughout.

On the Chicago and North-Western the coal was picked over, and latterly has even been loaded up with forks, so as to prevent small from getting in. Mr. Henderson spoke of the tendency to use an excess of oil. The track is found to suffer considerably. Both the consequences and the moral effect of accident at high speed are vastly increased, and there are indirect expenses brought about by high speed. A hot box on a freight car will be neglected in order that the freight train may be side-tracked out of the way of a coming express, and, in similar ways, damage is done that attention would have stopped. Then, again, the maximum business of a road is done when all trains run at the same speed. High speed trains put a very serious check upon the maximum capacity of a road. There must always be a slow train either following or followed by a fast train.

Figures from the C. B. and Q. Railroad of coal consumption point to the conclusion that, for an increase of speed of 53 per cent., there was an increase of coal of 92 per cent. Mr. Delano stated that where an ordinary service might cost $1 per mile, the limited express cost probably $2.

Given a sufficiency of traffic on, say, Behr's proposed system, and it may be supposed that a business of maximum capacity could be worked on such a line as a through line.

It is a pity the Behr line did not obtain Parliamentary sanction; but the claims made for it were too sweeping. Had the speed been kept down to 90 miles per hour, there would have been much less trouble in proving the preamble. Undoubtedly the brake question may be said to have wrecked the Behr line, but might it not have been passed, subject to limitation of the speed pending full demonstration of what could really be effected in the way of brake action? Just as we have pointed out that the difficulties of rounding a curve are entirely connected with the passengers' comfort or safety, so also it is feared is the braking power. Too rapid a stop, even by brakes, would not be permissible with passengers. True, they might all be nicely packed, so as not to be movable, but even then it is possible to conceive internal injury in weak constitutions. We do not ourselves think there would be much trouble with passengers on the braking question. Passengers could all be arranged to be supported against inertia effect. The danger of excessive braking power would be to the structure. A powerful grip brake on a heavy train would exert severe stress on the structure.

ADDRESS TO THE NEWCASTLE-ON-TYNE LOCAL SECTION OF THE INSTITUTION OF ELECTRICAL ENGINEERS.*

(*Abstract*)

ALL that is needed to signal the thoughts of the community from one place to another is the combined use of three things, built up of many parts—a source of electricity, a conductor of electricity, and an indicator of electricity.

Simple enough in these modern days—every electric bell hanger knows that, and sometimes knows how to do it. But consider what a mountain of labour and patient investigation were expended during more than a century, from 1729 to 1837, before the discoveries of great men were combined by the invention in the production of a practical electric telegraph.

Just look askance over one's shoulder down the back entry of Time. There are always the shadowy forms looming largely on the horizon, of Gray, an Englishman, who, in 1729, discovered the difference between conductors and insulators, using moistened pack thread for the former and silk loops for the latter; of our great Anglo-American Franklin, who, in 1753, with his kite in the sky, conducted the lightning to the earth, thus establishing its identity with electricity; of Galvani and Volta, the eminent Italians, who, from 1786 to 1789, developed one source of electricity, namely, the "chemical battery."

Here we may pause for a moment, having learnt in 70 years how to produce and how to conduct electricity in an elementary manner.

Then comes the achievement of a practical indicator of electricity—how to get it?—a somewhat complex problem. A needle, or armature of steel or iron, magnetised permanently or temporarily from any source, and responsive to every change in its electrical environment, yet controlled by man, a thing that no one at that time knew anything about practically, in a combined sense, though many lent wings to their imaginings in the effort to mentally satisfy the problem.

In 1844 the Electric Telegraph Company started the combined railway and public service, and in two years their operations extended to this neighbourhood, where they established a double needle circuit from Gateshead to York. At that time 13s. 4d. was charged for a message of 20 words from Gateshead to London *viâ* York. 1d. per mile for the first 50 miles, ½d. per mile for the second 50 miles, and ¼d. for every additional mile, with certain extras for porterage and addresses. Now, as is well known, since 1885, 20 [? 12] words cost 6d. to anywhere within Great Britain and Ireland. In 1849, the high level bridge across the Tyne was completed, and with it came the establishment of an office on the Sandhill. Newcastle's first direct connection with the metropolis was in 1851, when it was temporarily established with the first International Exhibition in Hyde Park. The double needle now began to give way to the single needle and the Bains' chemical recorder, which were succeeded by the Morse embosser in 1858.

In 1853-4, the Magnetic Telegraph Company using Highton's single needle and Bright's acoustic bell system, a forecast of the American sounder, came to Newcastle, with transmitting centres at Leeds and Carlisle, competitively reducing the before-named 13s. 4d. to 3s. as the Newcastle-London rate.

Another 10 years, and 1864 saw the 1s., or United Kingdom Telegraph Company in local existence using the Morse printer and the Hughes' type writer, invented in 1853-4-5.

But in 1867, a great jump was made by the introduction of the Wheatstone automatic apparatus; up to this time the usual controlling force in all signalling by battery contact, or interruption, was the hand of the operator which limited the speed of working on any wire to 30 or 40 words per minute at most.

The automatic apparatus was first introduced for practical work in this country between Newcastle-on-Tyne and London; Edinburgh and Glasgow following after.

Daily practical work is carried on with it at a normal speed of 330 words per minute on the local wires of this district, and between London and Birmingham 600 per minute; if duplexed, these figures become about 550 and 1,000 respectively.

In 1870 the Post Office acquired the telegraphs, and introduced the universal 1s. telegram, followed in 1885 by 6d. telegrams. The following figures give the traffic of this district for the year ending March 31st, 1900:—

Telegrams Forwarded.	Received.	Transmitted.	Total.
3,034,030	3,193,890	2,523,971	8,751,891

The first column is the money-earning one, and shows that, taking the population of the district at 2,000,000, rather more than 1½ messages per head of the population originate in the district per annum; but taking the forwarded and received, the traffic of the district is rather more than three per head of the population.

The wires provided in the district by the engineers' department amount to 14,889 miles, carried along 1,794 miles of route. 287 post offices absorb 323 sets of telegraph apparatus, and 1,244 private offices absorb 1,418.

The National Telephone Company's amount to *about* 5,000 exchange connections, using 6,657 miles of wire, serving 32 exchanges.

The telegraph offices in direct communication with Newcastle at the present time equal 155 served by 104 wires, exclusive of wires that pass through Newcastle *en route* for other places.

It may be mentioned here, that in 1868, the importance of Newcastle-on-Tyne telegraphically was greatly increased in consequence of the Anglo-Danish, now Great Northern Telegraph Company, commencing operations.

Their first cable was laid in 1868 by Mr. R. S. Newall, between Newbiggin-by-the-Sea and Sondervig on the west coast of Jutland, 335 nautical miles. The second cable was laid in 1873, between Newbiggin and Hirtsholson on the same coast, 430 nautical miles. The third cable was laid in 1880 between Newbiggin and Arendal in Norway, 520 nautical miles, and their fourth and last cable was laid in 1890, between Newbiggin and Marstrand in Sweden, 509½ nautical miles.

In addition, this company have two landlines to London, and one to Peterhead in Scotland, in connection with another submarine cable to Norway.

The apparatus employed is the undulator. So sensitive is the arrangement which works through the cables, and the landlines to Scandinavia at a normal speed of 80 words per minute simplex, and

* Delivered at the Durham College of Physical Science, May 15th, 1900, by the first Chairman, A. W. Heaviside, M.I.E.E., superintending engineer of the North-East (North) District of the British Postal Telegraphs.

120 duplex, that great care has to be taken to avoid lateral inductive effects.

The Commercial Cable Company and the Anglo-American Cable Company have each land wires to Newcastle to feed their cables.

Going back to 1859-60, at this time, the Universal Private Telegraph Company exploited the Wheatstone A B C Telegraph for private conversation at a rental. This was introduced into Newcastle in 1863. Out of it developed the A B C Exchange system, by which private circuits converging on a centre were joined together for conversational purposes. This was the forerunner of all telephone exchanges.

From May, 1877, to December 24th, 1880, much telephonic research work was done at Newcastle as well as elsewhere.

In 1881, a Post Office exchange was opened at Sunderland. It was joined up on the usual plan with the intermediate apparatus in sequence upon double wire twisted loops, as first suggested by Prof. Hughes. The apparatus in sequence choked the speech, threw the line out of balance, let in lateral induction, undoing the benefit of Hughes' twist. Shift was made in this district, as all over the world, with this arrangement, its imperfections being condoned. With underground work it died at four miles length; by putting one intermediate on one side of the loop and another on the other side, its life was resuscitated to 8 miles of underground work, and there speech stopped dead. But there was one, and one way only, to secure telephonic speech, unlimited as to distance and free from vagrant sounds. This was by what is known as the "Bridge."

Its efficiency was drastically put to the proof by partial use in 1881; it survived the whips and scorns of time, and was finally adopted *in toto*. Stockton was the first exchange entirely joined up in this manner; a new post office, involving new construction, was the opportunity. This exchange was opened on January 26th, 1885. The kernel of the system is that, by putting apparatus of great impedance at the intermediate points, vocal high frequency telephonic undulations gave the short circuit the go-by, whilst low frequency call-signal currents operated the signalling indicators at the Bridges *con amore*.

The operating in the Post Office system is arranged so that overhearing on the part of the switch clerks is unnecessary. A system of automatic block signalling by means of needle deflections telling the operators all they need to know, hence all the conversations are heard only by those whose property they are, the principals in the transaction.

Telephone trunk wires were early introduced in this district, the first being between Newcastle and Sunderland in 1883. In October, 1896, when the National trunk wires became the property of the State, the Newcastle service had already reached 33. To which had to be added the National giving a total of 68. Now they reach 72.

If to this is added all the towns now served by telephone trunk wires the total is 303. In the Tees to Tweed district, for the year ending March 31st the number of trunk calls reached 3,127,689, and local calls. Local Exchange calls reach about 12,000,000 per annum.

On April 14th and 15th, 1886, 14 years ago, on the Newcastle Town Moor, I proved with 120 reversals per second and ½ an ampere of current, that where earth returns were used, the earth could be tapped by driving the two ends of 4 yards of wire with a telephone in circuit into the earth.

It was also proved that with a secondary or with a primary only connected to earth at one point static effects could be easily detected, though diminished in loudness.

Farther, it was proved that if the distance from the primary was more than the length of the primary the effects diminished in loudness very rapidly.

From this time, until August 15th, 1886, the changes upon the above experiments were rung in many ways, always extending the distances, ending in Morse speaking across 40 miles of country, beween Shap and Gretna on the west, and Newcastle and Jedburgh on the east, produced by interrupting the vibrations with a Morse key. Up to this time, the primary wires were usually single wires put to earth at each end, and the secondaries insulated squares or rectangles, and the difficulty was to get a space large enough to lay out insulated wires on the surface without exciting the hostility of the tenants of the Northumberland Moors. However, Mr. Hugh Andrews, of Swarland Park, came to the rescue and placed his estate at my disposal.

Here it was, in the last week of August, 1886, that with two miles of insulated wire laid out as two squares of quarter-mile sides, and a quarter of a mile apart, or half-mile centres, that articulate telephonic talk was inductively held between one square and the other. Hearable with closed circuits; difficult to hear, but present, with open circuits. Of course, this test was with undulatory currents of microscopic value, and forms the highest testimony of the extraordinary sensitiveness of the telephone.

This was followed up by telephonically speaking from the workings of Broomhill Colliery to a triangle of insulated wire, three-quarters of a mile each side, laid roughly parallel over the colliery workings, the medium for the waves to travel being 360 feet of the crust of the earth.

(To be continued.)

ADMIRALTY ENGINEERING.

III.

Whether true or not, it is satisfactory to find that there is at least a report in circulation that the Belleville boiler is to be discarded. The report has certainly been contradicted, but we may hope that there is a good foundation for it, and that a weak place in the defence of the Empire is to be made good.

The *Engineer* continues its series on Admiralty engineering, and makes bold to state at this, the eleventh hour, that a very small defect in a fire-tube boiler will render it useless, as though this were not common knowledge years ago. The first boilers of the big cruisers were made with ordinary lap-welded tubes, such as can always be readily obtained. True, they were carefully inspected, but, says our contemporary, they failed lamentably, as every boiler expert knew they would fail, and continued to think they would fail after the glowing reports of the trials of the cruisers had been swallowed whole by nearly all the technical press, and just as the tubes of the Howard "Safety" boiler failed years ago. (See the Museum of the Manchester Steam Users' Association, 9, Mount Street, Manchester.) Solid drawn tubes were tried, and, to make a long story short, nothing would ever approach to satisfaction but a special Swedish steel.

It is stated that the inspection of such tubes as passed was so severe that the tubes cost 2s. per pound, and not 30 per cent. could pass inspection. Great sums were spent by firms who tried to carry out the Admiralty orders, and all to no purpose; the Swedish steel became practically compulsory, and for months past not a single Belleville tube has been made of English metal. Truly the Belleville boiler carries us back to the days of wood, for is not the Swedish steel made of charcoal-smelted ore? The *Engineer* has yet to learn the name of any other boiler that cannot be made of English metal.

To do our contemporary justice, it must be admitted that its persistent error of years is, if possible, being atoned for by the strenuous condemnation meted out to-day. The tubes made of the remarkably pure metal do not, it appears, blister, but are most easily corroded and readily punctured, and M. Bertin is quoted to show how difficult the Belleville boiler is to repair at sea. It is a little curious that we have searched M. Bertin's pages in vain for any really favourable remark on the Belleville boiler. Yet this M. Bertin is the chief engineer of the French Navy, which is full of Belleville boilers, and therefore England must adopt them. Well! the chief engineer of the French Navy cannot have been consulted on the question; unless, indeed, like a good patriot, he wished England to be in as bad a hole as France, for he has not written anything to praise the Belleville boiler, though he has, we believe, spoken nicely of M. Belleville himself, who appears to have been given a very free hand simply because M. Dupuy de Lôme so much appreciated his personal qualities.

Holes occur in the tubes after a few weeks at sea, and it is doubtful whether the boilers will last six years. By repeated renewals of lock, stock and barrel, a gun may last for 50 years, and be nominally the same gun. The Belleville boiler seems to be of this ilk, always being renewed, and therefore always sound and nearly new. But what is wanted is a boiler that will not wear out and need extensive renewal every few weeks. The *Engineer* winds up its third article with a good round condemnation of Admiralty methods and persistent obstruction. The American system, with Melville at the head of it, is compared favourably with our own, but it is only quite recently that the American Navy has been as good as ours. There was exactly the same trouble between line and engineers, and no engineers had power to speak a word any more than in the British Navy. Americans were fortunate in their recent unpleasantness in that the process of finding out the trouble was only concomitant with an enemy that was practically unarmed. It might have gone badly with them if, say, they had had to face Germany in the Philippines. The British Navy appear to have put a stop to this disaster.

We may be proud of our Naval men, but we are not proud of Admiralty ways with Naval engineers. The service is starved, and all hope of any real good being effected is hopeless until some strong man is appointed as engineer to sit at the Admiralty Board, none daring to make him afraid.

PRESENT METHODS OF SHIP WIRING.

Apropos of the fact that the *Oceanic*, the largest steamship in the world, has been fitted with an electric lighting system on the single-wire method, the hull of the ship serving as the return, Mr. Alton D. Adams, in the current issue of *Marine Engineering*, discusses the whole question of one and two-wire systems of electric distribution.

The practice mostly in vogue in America and, for the matter of that, in this country, is to run a complete copper circuit of two insulated wires, the system having no connection with the hull of the ship, double-pole switches and fuses being provided for all circuits. As is pointed out, the advantages of the one-wire system include a saving in both materials and labour. As all of the switches are single-pole, the weight of their metal parts is only about half of that required for double-pole switches. Fuses also being single-pole, their parts require only about one-half the weight and space of the two-pole type. A smaller number of switch and fuse parts require a smaller and more simple switchboard for mounting them, also smaller distribution panels at other points. The greatest saving of materials by one wire plant is in the weight of copper required for distribution.

Although it would appear that the single-wire system might under theoretical conditions save some 75 per cent. of the copper necessary in a two-wire system, the question of fall in pressure has considerable influence, while in many cases for the distances common in ship

work the limit of safe ampere capacity of wires will be found to require about the same size of conductors in many parts of the one-wire system as would be used for the two-wire. But in addition to the factors of mechanical strength and ampere carrying capacity, the question of the uncertain and usually increasing resistance of joints would tend to make it impracticable to reduce the wires of a one-wire system below the size that would be used in the corresponding half of a two-wire plant.

No doubt the single wire system is open to the disadvantages that would accrue to the possible corrosive action between the electric fittings and the ship's hull. As the writer points out, the joints between the electrical fittings and the steel hull of the ship grow old, and they are apt to develop a high electrical resistance through being loose or rusty; such loose joints may become a serious danger as fire risks because of their development of heat, against which no fuse on the circuit can guard. Mr. Adams maintains that in a two-wire plant one-half of the total electric pressure acts, under normal conditions, to break down the insulation of either wire or pole, while in a one-wire system, with hull return, the entire effort of the pressure is to pierce the insulation of the single-wire pole.

For security against this effect alone, therefore, the insulation of a single-wire system should be of double thickness. It is a regular practice in the erection of two-wire plants to instal at the switchboard a device that will indicate at once when an accidental ground, or in the case of ships, iron connection occurs in any part of the electric circuit, so that it may be removed. As a one-wire circuit with hull return is in direct contact with the iron of the ship at a great number of points, accidental contact in any place cannot be indicated at the switchboard, but is revealed only by the injurious effects it produces locally in the way of heat or fire at the place where it occurs. A very heavy iron connection might take so much current that an extra flow would be indicated by the ampere-meter, but this cannot be relied on, as the load is constantly changing in any event. On the two-wire system a single ground or iron connection produces no flow of current or bad results whatever until another ground or iron connection is made on the other side of the circuit, and there is usually opportunity to remove the first ground or iron connection before a second can occur. With one wire and a hull return there is damage at once when the first iron connection occurs, and no chance to remedy the faulty contact until the trouble happens.

Under ordinary circumstances the contact with terminals of about 110 volts pressure gives but a slight shock to most persons, but with 220 volt circuits, which are now coming into use for lamps and motors, very unpleasant sensations can be experienced. It is seldom that the user of lamps and fittings of an insulated two-wire system is exposed to shock, as he must make contact with both wires at some uncovered points simultaneously to produce shock, but with the one-wire plant a hand laid on the iron part of the ship, while the other is in contact with the wire or switch, will result in a discharge of current through the body. In the face of these facts, argues the author, the preference that is growing up for two-wire insulated circuits on ships seems to be well founded.

It should be added, however, that the use of 80-volt circuits is practically universal on board ship.

IMPERIAL TELEGRAPHIC COMMUNICATION.

In the course of the discussion on Sir Edward Sassoon's paper at the Society of Arts, May 28th, on "Imperial Telegraphic Communication," the following remarks were made by Mr. Charles Bright, F.R.S.E.:—

I should like to heartily congratulate Sir Edward Sassoon on the complete manner in which he has dealt with the subject. It is surely, however, unreasonable to expect the companies to reduce rates to 1s. when they have already assured us that they would have a dead loss at the reduction of rates from 4s. to 2s. 6d. Anyone who has followed up the history of submarine telegraphy from its infancy and preserved documents and newspaper records in connection therewith will know that, by their own showing, the companies should be losing heavily on the existing line to Australia, owing to having eventually conceded a certain reduction of tariff which they had previously assured us would mean a loss of many thousands a year. Assuming then that these heavy losses are a fact—notwithstanding large dividends and big reserve funds—surely we must not look to these companies to cripple themselves any further in other directions—such as India—but must look about us elsewhere to see if others are prepared to run the risk.

For my own part, I cannot think the risk is a very heavy one if sufficient enterprise be observed—such as that shown by railway companies in opening up new suburbs. I do not think that it has been sufficiently realised how often a supply creates a demand in matters telegraphic as much as in anything else.

Let us turn for a moment to the landline system of this country now in the hands of the State, and compare the number of messages daily conveyed over this system with what it was when the State, in taking over the lines from the companies in 1869, had to extend the telegraph to all manner of outlying and apparently non-paying stations. Let us, at the same time, compare the rates then with the present day. Whoever thought of sending a telegraph message in those days on domestic topics to the extent that they are sent nowadays at the 6d. rate? Just as telegraphic communication opens up a country and develops trade, so also low rates inspire the idea of using the telegraph where such a thing was never thought of before. I should like to know how many people would ever dream of using the submarine cable for domestic messages in the same way that they do the inland wire, except on vital occasions. Yet this might all be altered by proper reductions and a new use entirely come into vogue. I doubt if anyone, apart from business, even knows what steps to take to send a cablegram.

Surely it may be as much argued that the fact of the rates being high is the cause of the traffic being small as for the cause and effect to be put the other way. As Sir E. Sassoon points out, the submarine telegraph concerns the small business man more than anyone else, and to him it is a consideration whether he pays £1 or 10s. for a message. Surely, also, there is something illogical about the suggestion of the Secretary to the Treasury in the House of Commons last week, that because the carrying capacity of a cable is only about one-tenth of that of a landline, that, therefore, the rates should be higher on the latter. As a matter of fact, the carrying capacity of a cable can be increased to almost anything, provided that the traffic can be made sufficient so warrant the initial cost of construction suitable for high speed automatic transmission.

Again, Mr. Hanbury talks of the present cables to India being unable to carry more traffic if the rates were reduced. This surely only tends to show that so great would be the increase of traffic that we should require more alternative lines, which is true for a variety of reasons.

In point of fact, I fancy that the rates have been much more governed of late by considerations of competition, or the chances of competition, than by traffic consideration. In witness of this we have the fact that with Government competition (in the shape of the projected all-British Pacific cable) staring them in the face, the companies have already very much modified their contentions and tactics to which I have referred. We have an instance in the Cape to Australia cable (an excellent project, though in no sense obviating the need of a Pacific cable), which is now to be laid without any subsidy whatever, and at reduced rates, where previously one of £34,000 a year had been asked for a number of years and without any reduction of rates. Moreover, as a further result of outside criticism this line is now to go direct to Adelaide, instead of relying on an unsatisfactory landline from Perth. But it would take material time for them—with a proper sense of decency—to alter their terms (*i.e.*, to adopt our views under pressure) sufficiently for our purposes; and meanwhile we are kept waiting for the required reforms.

Let us now turn to the strategic aspect of submarine cables. In the House of Commons debate previously referred to, Mr. Hanbury in the course of his able speech, mentioned that any cables touching on foreign territory, could, if necessary, be cut at a moment's notice; but surely that as much as anything points to the desirability of a number of alternative cables on various routes, for just as we can easily cut cables, so can others—at any rate in shallow water—consequently we require more cables on out of the way routes and in deep water. With reference to the Government's objection to public inquiry, I may add there is nothing in regard to the landing places and working arrangements of existing submarine cables and their companies that foreign countries do not already know, or cannot easily acquire from existing publications, companies' meetings, &c.

I do not say I am entirely in favour of the State taking over the cable systems, but when it is remembered that the land telegraphs of this country were absorbed by the Government, though the companies who had previously worked them as a private speculation were not similarly responsible for the taxpayer's money, it seems as though the public had certainly more of a *locus standi* in the present case, so far as having some say in the administration of our submarine cable service to the Colonies and foreign countries.

As regards encroachment on private enterprise, I fully appreciate what has been done for us by the commercial pioneers—sometimes termed the pioneers, but that phrase is somewhat inapplicable to work in which engineering forms the base of operations. On the other hand, it must be remembered that any risk of capital that was made, was made for ordinary business purposes, and that their reward has already been very fully reaped on account of the policy pursued.

Whilst talking of subsidies, I observed that Mr. Hanbury in his speech drew a distinction between subsidies from the mother country and the Colonies; but surely in the case of cables from this country to the Colonies it should scarcely affect the argument in an Imperial Parliament what part of the Empire the subsidies come from as regards the Briton's right to have some voice in the matter.

I should like to know, in conclusion, what would be thought if there was any serious delay in the Imperial mail service? yet continual telegraphic breakdowns are of more urgent consequence.

BRISTOL TRAMWAYS AND THE PREVENTION OF ELECTROLYSIS.

During the proceedings of the spring meeting of the Southern District of Gas Engineers and Managers, held in Bristol on May 31st, the president, Mr. D. Irving, A.M.I.C.E., read a short paper in which he expressed warm appreciation of the arrangements adopted on the Bristol electrical tramways for the prevention of the electrolysis of gas and water mains. His paper was, in part, as follows:—

The Bristol Tramways Company, being one of the pioneers in the introduction of electric traction in England, it was thought a brief account of the manner in which the regulations made by Parliament in the Acts of the company, and the regulations issued and enforced by the Board of Trade for the protection of the mains of the water

and gas companies concerned, had been practically carried out by the Tramway Company, would be of interest to members of this association, especially as electric traction is now being so largely adapted throughout the country. With electric lighting systems, whether the supply is high tension alternating currents, or high, or low tension continuous currents, all conductors are continuously insulated throughout their entire length, and as a rule, in the best possible manner, with the result that it is not probable, and some electricians say, not possible, that there should be any stray current to escape that would seriously affect gas and water pipes. It will be readily understood that where such leakage does take place the fault is immediately developed, and the main is at once automatically burned out, cutting off the current. The slightest leakage can also easily be detected by the daily tests. And further, it is evidently of such vital importance to the electric lighting undertaking to prevent all such loss, that they may safely be relied upon to guard their own interests. It is now generally accepted, that with well insulated and strongly armoured cables and connections, no fear of electrolysis of water or gas mains need be feared from lighting installations. The electric system employed for traction generally is the continuous uninsulated. The overhead trolley wire is fed from the positive pole of the generator; the current passes through the motors fixed under the cars, performing its work of propelling, and then is delivered to the rails, which as you know, are connected to earth throughout their entire length. Up to this point, the circuit current is confined to a definite path, but on reaching the rails the trouble begins, the current may follow the rail back to the power station or ramify through the earth into the nearest water or gas main, always of course, like all forms of pent-up energy, taking the path of least resistance. It is the current passing from one metallic body to another, especially when embedded in certain classes of city earth, that causes electrolysis of rails and pipes. If the current in passing along the rail reaches an open joint, it will pass into the earth and back into the rail or nearest pipe, and so on in and out. It will at once be seen that the whole question of leakage and electrolysis depends upon the proper electrical bonding of the rails, which are sufficient in themselves, except on very large sections, and offer abundant conductivity to carry the current. The bonding of these rails has been a matter of much study and gradual development. Great improvements have been made since the first introduction of electric traction in this country. The tram rails in Bristol are "fished" together with no less than five plates, one on each side of the webb in the usual manner, and one covering the entire underside and two strips on the upper side of the bottom flange of the rail, bolted up with 14 bolts. The rails are double bonded at each joint with copper bonds $\frac{7}{16}$ inch diameter, electrically connected to the webb of each rail. There is also a third electric connection formed by Edison's plastic bond, carefully prepared and fixed between the rail and the fish plates. In addition to these bonds, and in order to make certain of one continuous conductor, a double cross copper bond is fixed every 120 feet length of rail, so that should any individual rail bond fail, the cross bonds, which are each $\frac{7}{16}$ inch diameter, will take up the current. Not less than 7s. per single joint is being spent in electric bonds by the traction company in order to secure the property of their neighbours and the economical and profitable working of their own undertaking. In addition to this careful and improved system of bonding the rails so as to retain the return current and make the rails the way of least resistance, a booster has been introduced by the consulting engineer of the tram company, whereby the negative current is drawn from the tram rail very much in the form of a gas exhauster drawing gas. In the Bristol Tramways Act (57 and 58, Vic, 1894), the following clauses, forming part of Section 31, were inserted for the protection of the Bristol gas and water and other companies:—

1. The company shall employ either insulated returns or uninsulated metallic returns of low resistance.

2. The company shall take all reasonable precautions in constructing, placing and maintaining their electric lines and circuits and other works of all descriptions, and also in working their undertaking, so as not injuriously to affect by fusion or electrolytic action any gas or water pipes, or other metallic pipes, structures, or substances.

3. The exercise of the powers by this Act conferred, with respect to the use of electric power, shall be subject to the regulations set forth in the first schedule of this Act, and to any regulations which may be added thereto or submitted therefor respectively by any order which the Board of Trade may, and which they are empowered to make, from time to time, as or when they may think fit, for regulating the employment of insulated returns, or of uninsulated metallic returns of low resistance, for preventing fusion, or injurious electrolytic action of, or on gas or water pipes, or other metallic pipes, structures, or substances; and for minimising, as far as is reasonably practicable, injurious interference with the electric wires, lines and apparatus of other parties and the currents therein, whether such lines do or do not use the earth as a return.

4. The company using electric power contrary to the provisions of this Act, or to any of the regulations set forth in the first schedule to this Act, or to any regulation added thereto, or substituted therefor, by any order made by the Board of Trade under the authority of this Act, shall, for every such offence, be subject to a penalty not exceeding £10, and also in the case of a continuing offence to a further penalty not exceeding £5 for every day during which such offence continues after conviction thereof. Provided always that, whether any such penalty has been recovered or not, the Board of Trade, in case in their opinion the company, in the use of electric power under the authority of this Act, have made default in complying with the provisions of this Act, or with any of the regulations set forth in the first schedule to this Act, or with any regulation which may have been added thereto or substituted therefor as aforesaid, may, by order, direct the company to cease to use electric power, and thereupon the company shall cease to use electric power, and shall not again use the same unless with the authority of the Board of Trade, and in every such case the Board of Trade shall make a special report to Parliament notifying the making of such order.

In connection with the Board of Trade Regulations, I am glad to be able to inform you that the potential difference in Bristol, between the points of the uninsulated return furthest from and nearest to the generating station, does not now exceed from 2 to 3 volts, a result unheard of some two or three years ago. However much some may be inclined to regret the introduction of electric traction in our crowded streets, there is no doubt but that it renders a great public service. A system that can take our workmen from his work in the City, and put him down nearly at his own cottage door, three or four miles out in the country, for the sum of 1d., is well calculated to assist in solving the problem of overcrowding in our large cities. The Bristol Tramways Company are, I understand, spending over half a million pounds in improving and extending their system, and in conclusion, I feel compelled to express my admiration for the bold, enterprising, and generous conception of their schemes, and the energetic, persistent, and thorough manner in which all their work is executed by the managers and engineers of the company.

The gas engineers, while in Bristol, visited the electrical station now in course of construction, and also the St. George's power house.

NEW PATENTS AND ABSTRACTS OF PUBLISHED SPECIFICATIONS.

NEW PATENTS.—1900.

Compiled expressly for this journal by W. P. Thompson & Co. Electrical Patent Agents, 322, High Holborn, London, W.C., and at Liverpool, Manchester and Birmingham, to whom all inquiries should be addressed.

9,306. "Improvements in or relating to methods of extracting gold by electricity." G. H. Smith. Dated May 21st.

9,331. "An improved electrolysing apparatus." M. Haas. Dated May 21st. (Complete.)

9,339. "Improvements relating to multiplex telephony." W. E. Evans. (E. A. Faller and J. W. Chisholm, United States.) Dated May 21st.

9,397. "Improvements in armatures." G. Heidel. Dated May 22nd. (Complete.)

9,398. "Improvements in electric shampooing apparatus." H. C. Doersch. Dated May 22nd. (Complete.)

9,413. "Improvements in electric motor suspension." G. Gibbs. Dated May 22nd. (Complete.)

9,424. "Improvements relating to electric incandescent lamps." R. Kaiser. Dated May 22nd.

9,458. "Improvements in space telegraphy." W. C. L. Eglin. Dated May 22nd. (Complete.)

9,464. "Improvements in the manufacture of filaments for incandescent electric lights." S. B. Husselman. Dated May 22nd. (Complete.)

9,469. "Improvements in motor meters for alternating currents." A. Peloux. Dated May 24th.

9,486. "Apparatus for converting electrical into mechanical energy suitable for actuating pumps and other reciprocating mechanisms." D. Hunter and W. A. Jack. Dated May 24th.

9,492. "Improvements in ceiling roses and other similar electrical connections." W. McG. Douglas. Dated May 24th.

9,503. "Improvements in electric igniters for explosion engines." T. Bergmann. Dated May 24th. (Complete.)

9,507. "Improvements in apparatus for exciting dynamo-electric machines." A. G. Cooper. Dated May 24th.

9,511. "Improvements in the construction of swivel heads of electric car trollies." I. F. Cuttler. Dated May 24th.

9,533. "Method of exciting alternating current machines." P. M. J. Boucherot. Dated May 24th.

9,534. "Improved method of starting multiphase current motors." P. M. J. Boucherot. Dated May 24th.

9,522. "Improvements in electric arc lamps." H. Bremer. Dated May 24th. (Complete.)

9,561. "Improvements in fuseboards for electric lighting and the like." C. Curwen. Dated May 24th.

9,563. "An electrolysing process for zinc and other salts with soluble anodes." C. D. Abel. (La Societe des Piles Electriques, France.) Dated May 24th.

9,567. "Improvements in electric traction on a road contact or like system." S. P. Thomason. (Partly by M. Walker, United States.) Dated May 24th.

9,576. "Improvements in telegraphic transmitting, receiving and translating arrangements." A. Muirhead. Dated May 24th.

9,579. "Improvement relating to telephonic apparatus." V. Veysy. (Date applied for under Patents, &c., Act, 1883, Sec. 103, October 24th, 1899, being date of application in France.) Dated May 24th.

9,592. "Improvements in accumulators or secondary batteries for traction, motive power or lighting purposes." A. Bluhm and J. Posnansky. Dated May 24th.

9,612. "Improvements in a commutating switch and combinations of electric motors and batteries for controlling electric carriages and like purposes." H. F. Joel, sen. Dated May 24th.

9,632. "Improvements in or relating to electric storage batteries." J. T. Niblett, M. Sutherland, and E. Marcuson. Dated May 25th.

9,681. "A new or improved detective lock or seal for gas and electric meters electrical demand indicators and fuse boxes or for any other uses or purposes to which same may be applicable." C. O. Bastian. Dated May 25th.

9,632. "Improvements in electrical accumulators or secondary batteries." W. Hibbert. Dated May 25th.

9,654. "New or improved dies for making socketed conduits." J. Hamblet and I. Parkes. Dated May 25th.

9,699. "Improvements in or relating to electric clocks or watches." A. J. Henderson. Dated May 26th.

9,711. "Improvements in protective devices for use in the distribution of high tension alternating currents." R. P. Wilson. Dated May 26th.

9,716. "Improved electric railway conduit." E. B. Viles. Dated May 26th.

9,730. "An improvement in electric switches." F. S. WORSLEY and F. J. GREEN. Dated May 26th. (Complete.)

9,731. "Improvements in apparatus for use in the electro-deposition of metals." S. O. COWPER-COLES. Dated May 26th.

9,744. "Improvements in telegraphy." J. LEA and J. TAYLOR. Dated May 26th.

9,746. "Improvements in electrolytic meters." A. WRIGHT and THE REASON MANUFACTURING COMPANY, LIMITED. Dated May 26th.

ABSTRACTS OF PUBLISHED SPECIFICATIONS.

Copies of any of these Specifications may be obtained of Messrs. W. P. THOMPSON and Co., 322, High Holborn, W.C., and at Liverpool, Manchester, and Birmingham, price, post free, 9d. (in stamps).

1898.

10,617. "A controlling switch for large numbers of electric circuits." H. K. Smith and J. Eck. Dated May 9th, 1898. Switches for controlling groups of circuits in succession. A drum having a number of holes adapted to receive contact studs is connected through a spring contact with one end of the circuits to be controlled. The other ends of the circuits are connected to contact springs with which the studs engage as the drum rotates. The numbers and relative positions of the studs are varied as desired. Instead of the drum, a reciprocating plate may be employed. 4 claims.

10,618. "An improved indicating and recording apparatus for use in connection with electric meters." G. C. Pillinger. Dated May 10th, 1898. Energy and quantity meters of any description are each provided with two counting mechanisms, one or other of which is placed in gear with the driving worm of the meter in accordance with the strength of the current being supplied. Two separate records are thus obtained, for light and heavy loads respectively. The two counters are carried adjustably by a beam, movable between stops about a support. The current is supplied through a solenoid, the core of which is supported by an auxiliary lever, which raises the adjacent end of the beam, when the current is sufficiently strong, in opposition to its weighting. The auxiliary lever may be in two parts connected by a pin and slot, and acted on by a spring, to prevent the beam from standing with neither counter in gear. 2 claims.

10,705. "Improvements in electric motors and meters adapted for use with alternating currents." H. P. Davis and F. Conrad. Dated May 10th, 1898. (Date claimed under Patents, &c., Act, 1883, Sec. 103, October 22nd, 1897, being date of application in United States.) Relates to electric motors and meters. Single-phase alternating current motors have fields arranged in such a manner that the armature rotates within pole-pieces carried by parts of an iron ring, separated by non-magnetic gaps. Single magnetic circuit is produced around the ring by a continuous winding. The pairs of the adjacent pole-pieces are wound with coils which are connected in series, and are supplied with current through an adjustable resistance in parallel with the winding. By these arrangements each pair of pole-pieces produces a shifting field. In a modified form the coils are carried by radiating poles of a stationary core within the armature, opposite the pairs of pole-pieces. A further modification is provided with a disc armature for use in a motor meter. An iron core terminates in pole-pieces separated by a small non-magnetic gap, and situated opposite a single pole-piece at the middle of the core. A conducting disc passes between these poles, and is carried by a spindle geared to a counter. A disc also passes between the poles of a permanent magnet. A single magnetic circuit is produced around the whole core and across the gap by two coils, which are connected in series with an inductance between the supply mains. The main current passes through a coil on the pole-piece. The magnetic fluxes due to the coils are preferably in quadrature when the main circuit is not reactive, and to obtain this result, coils on the core are connected into a closed circuit with an adjustable resistance. At one side the core is surrounded by a coil or single turn of conductor connected with an adjustable resistance to produce a starting torque sufficient to compensate for friction. The disc may pass between magnetic currents in the main coil. The meter may be modified for multi-phase currents, or to indicate the total energy supplied in two separate circuits. 2 claims.

10,710. "An improved dry battery." J. Weiss. Dated May 10th, 1898. The invention has reference to dry batteries. The battery consists of a zinc vessel and a carbon rod around which is packed a mixture of pyrolusite and graphite bound together by a solution of a caustic alkali, and a solution of zinc chloride absorbed in a mass of sawdust or the like. The cell is closed by a layer of asphalt and colophont in which is a tube serving as a gas exit. 1 claim.

10,818. "Improvements in electricity meters." G. Hookham. Dated May 11th, 1898. Relates to energy meters for alternating currents. A meter having a conducting disc or other body is rotated by main current coils placed near the poles of a shunt wound magnet between which poles the disc passes; proportionality of registration of different loads is obtained by varying or distorting the field of the magnet. This may be effected by providing the upper pole with a pivoted pole-piece or with vertically-sliding pole-pieces above the coils and adjusting these as is found necessary. A quantity meter for continuous currents is also described. 8 claims.

10,865. "Improvements in electrical switches." A. V. Glikins and F. R. Hill. Dated May 13th, 1898. The invention relates to electric switches. A series of plates forming the movable contact is placed in a carrier provided with a handle and spring adapted to give a quick break. Between each plate is arranged a spring distance piece, and through them is passed the screw which engages a nut. The plates have a slight longitudinal movement on the screw, so that each can be independently adjusted between the fixed contacts. The number of plates can be proportioned to the current. 2 claims.

11,075. "Improvements in electrical apparatus for producing luminous or similar effects, such as Rontgen rays, from exhausted receivers." W. L. Wise. (The Moore Electrical Company.) Dated May 14th, 1898. Apparatus for producing luminous and like effects in vacuum tubes by rapidly interrupting a circuit having self-induction. The interrupter is vibrated by the magnets, the former being constantly energised and the latter at intervals. The circuit is made and broken at a fixed contact. A solenoid apparatus is provided to jar the chamber should the working become abnormal. The solenoid is sluggish and does not act on its core when the circuit is being rapidly interrupted, but should it become abnormal, the core is withdrawn and contact broken. The core then falls, striking a vessel. Modifications of this electro-magnetic striker are described, in some of which the core or hammer strikes the frame of the apparatus. The magnets provide the self-induction, which is equal on each side of the break. In modified arrangements, the arm may be replaced by a spring interrupter which is operated by magnets energised alternately by the commutator. In a further arrangement, a number of interrupters are arranged around a common constantly energised magnet, the vibrators being actuated by a number of magnets alternately energised through a suitable rotary commutator. The interrupter may be arranged to make and break the circuits alternately on either side of a three-wire system. Additional contacts may be fitted within the vessel to come successively into use to replace the worn contacts. 12 claims.

11,076. "Improvements in and relating to telephone installations." E. Baivy. Dated May 14th, 1898. Relates to the arrangement of double flap annunciators in both the subscribers' lines or operator's apparatus. The two coils are arranged in series in the loop so that a signal sent along line with earth return operates the annunciator, but when the complete metallic loop is used no effect is obtained. The operator's apparatus is shown with a battery in the annunciator earth, but the annunciator may be divided into two separate parts, when multiple contact jacks are employed and the battery connected to one coil, an additional battery being inserted between the key and earth. 1 claim.

11,158. "Improvements in and connected with the control of electrically propelled vehicles and trains." H. H. Leigh. (F. J. Sprague.) Dated May 16th, 1898. Relates to methods of controlling electrically driven trains from any desired point on the train, which may be built up of vehicles arranged in any order and any or all of them carrying one or more driving motors or none at all. In the simplest form two wires run the length of the train and have connected to them in parallel all the driver's controllers, so that current can be sent from the main supply to either of the solenoids whereby the circuits to the motors are made for forward or backward running. Instead of the simple make and break switches actuated by these solenoids, resistance switches may be used. In another form, a pilot motor with magnetic brake operates the arm of a resistance switch or rheostat, and this arm knocks over the reversing switch according to the direction of the pilot motor. This motor works in connection with three train leads, and is arranged so that it reverses its own connections at the end of its stroke, so that the driver by manipulating any one of the controllers can return the motor switch and reverser to the mid or other position. In a more complicated form the reversing switch for the driving motors is operated by the plungers and solenoids supplied from the two leads running through the train. A switch of the series-multiple type for controlling the motors is driven by the pilot motor. On this last-named switch are a number of extra contacts, which control the current supply to the pilot motor, and these work in conjunction with solenoid-operated switches and train leads, which may be connected to the current supply by the same driver's switch that works over the directional leads. The arrangement of these various solenoids and other switches is such that the pilot motor is driven at a predetermined rate to put the motor switch into "coast," "series," or multiple positions practically with a step-by-step movement, as the solenoid acts as a throttle cutting off the current to the motor if it runs too fast. The arrangements are described at length in the specification, with the aid of a number of positional diagrams. In addition, numerous modifications of the details of the arrangements of these several switches and connections are indicated or described. In order that similar movements to the right or left of any one of the driver's switches may produce corresponding results, the forward contact on one switch must be connected to the backward one on the other switch on the same car, and all the forward contacts on the leading ends of the several cars must be connected, and similarly with the other contacts. For this purpose the train wires, whether two or more in number, are arranged in such positions or with such forms of couplings that only the proper contacts can be connected whatever may be the position of the vehicle. 34 claims.

11,158a. "Improvements in electrical couplings for railway cars." H. H. Leigh. (F. J. Sprague.) Dated May 16th, 1898. Relates to couplings for electrically-propelled vehicles which are equipped to form trains as described in Specification No. 11,158, of 1898. The couplings are arranged so that the speed controlling wires may be properly connected, even though the cars are reversed. Couplings of like construction are secured at the end of each car, and connection is made by a detachable connecting piece. The speed controlling wires are arranged vertically, and the direction-controlling wires horizontally. The fixed part of the coupling is completely shrouded, and carries the contact plugs on an insulating block. The flexible connecting piece is fitted with a socket piece at each end, and with a key to fit in the keyway. The ends have a bell-mouth guide for limiting the curvature of the connection. An arrangement is described in which a detachable connecting piece is not employed. The half-couplings are fitted with projecting insulating pieces on which contacts are suitably arranged. 4 claims.

11,158b. "Improvements in pilot apparatus and reversing mechanism for controlling electric motors." H. H. Leigh. (F. J. Sprague.) Dated May 16th, 1898. Relates to apparatus for controlling motors used for traction purposes such as are described in Specification No. 11,158 A.D., 1898. A number of vehicles are adapted to be coupled up as a train, and each vehicle has a controller operated by a pilot motor controlled by a master controller. The reverser switch and main or series multiple switch may be mounted on one base. The main switch is driven by the pilot motor through worm gearing, and a flexible coupling, notched wheels serving to hold the switch in the proper positions. The reversing switch is operated when one of a pair of cores is drawn within the corresponding coil. The cores fit closely to the tube of the coil, so as to form a dash-pot arrangement, and blow-out magnets are fitted around the contacts to minimise arcing. In modified arrangements, the reversing, the resistance, and the series multiple switches are separately controlled, and additional switches are provided for cutting out the pilot motor when the main switch is in its limiting positions. 8 claims.

11,175. "Improvements in switches for electric circuits." C. B. Callow and J. Eck. Dated May 17th, 1898. Relates to means for rapidly moving the switch contacts, in multiple way switches, from one position to the next with precision and independently of the rate of movement of the handle. A segment is rigidly fixed on the spindle of the switch, and is connected to an arm connected to the handle by springs. The segment is held against movement by spring detents. On turning the handle, one of the springs is put in tension until the arm depresses a detent, when the spring pulls the segment round against the next detent. These detents are arranged in desired relationship with the contacts of the switch. A projection may be fitted on the arm to engage with projections on the segment to start the movement. In order to prevent distortion of the springs they are connected to plates hinged to the segment. This method of controlling the position of the contacts is also applicable to sliding switches. 7 claims.

11,858. "Improvements in the manufacture of elements or plates for secondary batteries or electric accumulators." F. King. Dated May 28th, 1898. Relates to means for making perforations or interstices in the active material of plates or electrodes. The plate or grid packed with active material is covered on each side with a layer of semi-elastic or compressible material, such as felt or asbestos, and the whole is compressed between plates, and, while in a state of compression, the active material is perforated by needles which pass through holes in the plates. Needles may enter the active material from both sides of the plates, and may only partly penetrate it. 1 claim.

11,926. "Improved circuit connections for continuous current shunt machines." A. Sengel. Dated May 25th, 1898. Relates to improved circuit connections for continuous current shunt machines, whereby the magnets are excited with only half the potential at the brushes. One end of the shunt is connected with one of the brushes of the main line, and the other is connected through a regulating resistance with a third brush, which rubs upon an insulated ring connected with any point of the armature, for example, by a commutator segment. When this arrangement is applied to motors, one end of the shunt circuit is connected by the contact bar of the starting resistance with one pole of the lead, and the other is connected to third brush. The ring may be dispensed with when the armature winding is connected with the magnet frame, and one end of the shunt circuit is connected with the frame instead of to the third brush. 2 claims.

11,962. "Improvements in automatic prepayment mechanism for controlling the supply of electricity or gas." J. Hughes. Dated May 26th, 1898. Electric lighting; gas meters. An electric switch or a gas cock is turned to give a supply by winding up a spring which drives a controlling flyer through a train of wheels, and the supply continues till the spring has run down. Only a single revolution of the winding stem is necessary, and when this is completed, a lug upon it makes a lever displace the detent from the flyer. When the spring is run down the lug is on the other side of the lever. The switch may be operated by the detent-displacing lever, but it may be on an arm which is displaced when the winding is complete from a notch in a disc that revolves as the spring runs down and so keeps the switch in the contact position. Coin action; coin discharging mechanism. The ordinary stem is pierced by a slot into which the coin drops from a shoot. A split key will then turn the stem, and the coin will throw a rocking pallet over, in which it stops the coin from falling out of the slot. When the coin is released by the key it drops into the receptacle below, and in doing so resets the rocking pallet. 4 claims.

12,191. "Improvements in reflectors, chiefly designed for incandescent electric lamps." C. Bartenstein. Dated May 28th, 1898. A bowl shaped glass reflector has its reflecting surface formed of numerous concave or convex facets. Such reflectors are especially applicable to electric incandescent lamps, to avoid the projection of images of filaments upon the surfaces to be illuminated. 1 claim